E.8 Impacts of Implementation Alternatives of the Spent Nuclear Fuel Acceptance Policy

E.8.1 Implementation Alternative - Implementing an Acceptance Policy of Alternative Amounts of Spent Nuclear Fuel - Accept only from Developing Nations

This implementation alternative was analyzed using the same set of assumptions as used in analyzing the basic implementation. The results are as follows:

Shipments

Under all SNF&INEL Final EIS (DOE, 1995) alternatives, the shipment of foreign research reactor spent nuclear fuel would require the movement of 168 casks from ports of entry to DOE facilities. The basic shipment count, by point of origin is:

	East Coast		West Coast		
	Aluminum	TRIGA	Aluminum	TRIGA	Totals
Phase 1	31	54	15	30	130
Phase 2	9	16	4	9	38
Totals	**40**	**70**	**19**	**39**	**168**

Calculated in the same manner as described in Section E.7.2.1, the number of intersite shipments for two-phased approaches to this alternative varies between 4 and 33. The variation is caused by the wide variety of phased approaches.

Impacts of Incident-Free Ground Transport

The incident-free transportation of spent nuclear fuel was estimated to result in total latent fatalities that ranged from 0.002 to 0.06 over the entire duration of the program. These fatalities are the sum of the estimated number of radiation-related LCFs to the public and the crew.

The range of fatality estimates is caused by three factors: 1) the option of using truck or rail to transport spent nuclear fuel, 2) combinations of Phase 1 and Phase 2 sites that created varying shipment numbers and distances, and 3) the difference between the risk factors for the port-to-site routes.

The estimated number of radiation-related LCFs for transportation workers ranged from 0.001 to 0.015. The estimated number of radiation-related LCFs for the general population ranged from 0.0006 to 0.045, and the estimated number of nonradiological fatalities from vehicular emissions ranged from 0.0002 to 0.01.

Impacts of Accidents During Ground Transport

The cumulative transportation accident risks over the entire program are estimated to range from 0.0000001 to 0.00006 LCFs from radiation and from 0.0001 to 0.028 for traffic fatality, depending on the transportation mode and DOE sites selected. The reasons for the range of fatality estimates are the same as those described for incident-free transportation. Both indicate an expectation of less than one fatality.

The impacts of overland transportation are shown in Tables E-22 through E-30. The analysis for this alternative implementation is analogous to the analysis performed for the Basic Implementation (see Section E.7.2), and the interpretation of the tables is the same as described in Section E.7.2.

The consequences of the most severe accident hypothesized are the same as described for the Basic Implementation since the material at risk is the same.

Table E-22 Tabulation of Overland Transportation Risks: Spent Nuclear Fuel from Developing Nations Only, All Shipments via Truck, Average Risk Factors

Alternative / Option			Routine			Accidental	
Programmatic SNF & INEL EIS Alternative	SNF Site Option	Phase I Approach	Radiological		Nonradiological		Radio-logical
			Crew	Public	Emis.	Traffic	
Decentralization	INEL/SRS		0.0034	0.0106	0.0005	0.0063	0.000003
1992/1993 Planning Basis	INEL/SRS		0.0034	0.0106	0.0005	0.0063	0.000003
Regionalization by Fuel Type	INEL/SRS		0.0098	0.0309	0.0016	0.0182	0.000011
Regionalization	INEL/SRS		0.0034	0.0106	0.0005	0.0063	0.000003
by	INEL/ORR	Geographic	0.0040	0.0120	0.0006	0.0072	0.000009
Geography		By Fuel	0.0087	0.0273	0.0014	0.0161	0.000012
		All to INEL	0.0096	0.0303	0.0015	0.0178	0.000010
	NTS/SRS	Geographic	0.0039	0.0120	0.0007	0.0071	0.000005
		By Fuel	0.0091	0.0285	0.0016	0.0167	0.000014
		All to SRS	0.0070	0.0215	0.0012	0.0127	0.000007
	NTS/ORR	Geographic	0.0044	0.0134	0.0008	0.0080	0.000011
		By Fuel	0.0094	0.0295	0.0017	0.0173	0.000017
		All to INEL	0.0106	0.0335	0.0018	0.0195	0.000018
		All to SRS	0.0077	0.0234	0.0014	0.0140	0.000016
	HS/SRS	Geographic	0.0035	0.0109	0.0005	0.0064	0.000003
		By Fuel	0.0086	0.0272	0.0013	0.0159	0.000010
		All to SRS	0.0067	0.0205	0.0011	0.0122	0.000007
	HS/ORR	Geographic	0.0040	0.0122	0.0006	0.0073	0.000009
		By Fuel	0.0090	0.0281	0.0014	0.0165	0.000013
		All to INEL	0.0101	0.0319	0.0015	0.0185	0.000012
		All to SRS	0.0074	0.0224	0.0012	0.0134	0.000016
Centralization	INEL		0.0112	0.0356	0.0017	0.0208	0.000012
	SRS		0.0078	0.0241	0.0013	0.0142	0.000008
	HS	Geographic	0.0078	0.0245	0.0011	0.0142	0.000025
		By Fuel	0.0119	0.0377	0.0018	0.0219	0.000023
		All to INEL	0.0120	0.0384	0.0018	0.0221	0.000014
		All to SRS	0.0120	0.0375	0.0019	0.0220	0.000039
	NTS	Geographic	0.0077	0.0237	0.0014	0.0146	0.000030
		By Fuel	0.0119	0.0376	0.0021	0.0224	0.000028
		All to INEL	0.0123	0.0390	0.0022	0.0229	0.000020
		All to SRS	0.0117	0.0361	0.0020	0.0221	0.000043
	ORR	Geographic	0.0056	0.0173	0.0008	0.0105	0.000017
		By Fuel	0.0110	0.0347	0.0017	0.0207	0.000026
		All to INEL	0.0127	0.0404	0.0019	0.0240	0.000032
		All to SRS	0.0083	0.0255	0.0014	0.0153	0.000017

All risks are expressed in latent cancer fatalities during the implementation of the policy, except for the Accidental-Traffic column, which is a number of fatalities.

Table E-23 Tabulation of Overland Transportation Risks: Spent Nuclear Fuel from Developing Nations Only, Shipments from Ports via Truck, Intersite Shipments via Rail, Average Risk Factors

Alternative / Option			Routine			Accidental	
Programmatic SNF & INEL EIS Alternative	SNF Site Option	Phase I Approach	Radiological		Nonradiological		Radio-logical
			Crew	Public	Emis.	Traffic	
Decentralization	INEL/SRS						
1992/1993 Planning Basis	INEL/SRS						
Regionalization by Fuel Type	INEL/SRS						
Regionalization by Geography	INEL/SRS						
	INEL/ORR	Geographic	0.0037	0.0111	0.0006	0.0065	0.000004
		By Fuel	0.0086	0.0268	0.0014	0.0157	0.000009
		All to INEL	0.0096	0.0303	0.0015	0.0178	0.000010
	NTS/SRS	Geographic	0.0036	0.0111	0.0006	0.0066	0.000003
		By Fuel	0.0086	0.0269	0.0015	0.0158	0.000009
		All to SRS	0.0070	0.0215	0.0012	0.0127	0.000007
	NTS/ORR	Geographic	0.0039	0.0115	0.0007	0.0068	0.000004
		By Fuel	0.0088	0.0273	0.0015	0.0160	0.000010
		All to INEL	0.0098	0.0308	0.0016	0.0181	0.000011
		All to SRS	0.0072	0.0220	0.0013	0.0130	0.000009
	HS/SRS	Geographic	0.0033	0.0101	0.0005	0.0060	0.000003
		By Fuel	0.0083	0.0258	0.0013	0.0152	0.000009
		All to SRS	0.0067	0.0205	0.0011	0.0122	0.000007
	HS/ORR	Geographic	0.0035	0.0105	0.0006	0.0063	0.000004
		By Fuel	0.0085	0.0263	0.0014	0.0155	0.000010
		All to INEL	0.0095	0.0298	0.0015	0.0175	0.000011
		All to SRS	0.0069	0.0210	0.0012	0.0125	0.000008
Centralization	INEL						
	SRS						
	HS	Geographic	0.0057	0.0171	0.0010	0.0099	0.000009
		By Fuel	0.0105	0.0328	0.0018	0.0191	0.000014
		All to INEL	0.0115	0.0363	0.0018	0.0211	0.000013
		All to SRS	0.0091	0.0277	0.0017	0.0161	0.000016
	NTS	Geographic	0.0057	0.0172	0.0012	0.0103	0.000010
		By Fuel	0.0106	0.0329	0.0019	0.0195	0.000014
		All to INEL	0.0115	0.0364	0.0019	0.0215	0.000013
		All to SRS	0.0091	0.0277	0.0019	0.0165	0.000016
	ORR	Geographic	0.0045	0.0137	0.0008	0.0082	0.000006
		By Fuel	0.0095	0.0295	0.0016	0.0174	0.000013
		All to INEL	0.0106	0.0331	0.0018	0.0194	0.000015
		All to SRS	0.0079	0.0241	0.0013	0.0143	0.000009

All risks are expressed in latent cancer fatalities during the implementation of the policy, except for the Accidental-Traffic column, which is a number of fatalities.

Table E-24 Tabulation of Overland Transportation Risks: Spent Nuclear Fuel from Developing Nations Only, All Shipments via Rail, Average Risk Factors

Alternative / Option			Routine			Accidental	
Programmatic SNF & INEL EIS Alternative	SNF Site Option	Phase I Approach	Radiological: Crew	Radiological: Public	Nonradiological: Emis.	Nonradiological: Traffic	Radio-logical
Decentralization	INEL/SRS		0.0015	0.0011	0.0010	0.0002	0.000001
1992/1993 Planning Basis	INEL/SRS		0.0015	0.0011	0.0010	0.0002	0.000001
Regionalization by Fuel Type	INEL/SRS		0.0027	0.0027	0.0034	0.0006	0.000003
Regionalization by Geography	INEL/SRS		0.0015	0.0011	0.0010	0.0002	0.000001
	INEL/ORR	Geographic	0.0018	0.0023	0.0010	0.0008	0.000001
		By Fuel	0.0028	0.0035	0.0029	0.0011	0.000003
		All to INEL	0.0029	0.0036	0.0031	0.0011	0.000003
	NTS/SRS	Geographic	0.0019	0.0027	0.0011	0.0010	0.000001
		By Fuel	0.0029	0.0039	0.0030	0.0014	0.000003
		All to SRS	0.0025	0.0038	0.0025	0.0013	0.000002
	NTS/ORR	Geographic	0.0023	0.0037	0.0011	0.0017	0.000007
		By Fuel	0.0035	0.0057	0.0031	0.0023	0.000008
		All to INEL	0.0039	0.0068	0.0035	0.0028	0.000010
		All to SRS	0.0027	0.0039	0.0026	0.0013	0.000003
	HS/SRS	Geographic	0.0016	0.0017	0.0009	0.0005	0.000001
		By Fuel	0.0026	0.0029	0.0028	0.0008	0.000003
		All to SRS	0.0022	0.0028	0.0024	0.0007	0.000002
	HS/ORR	Geographic	0.0020	0.0027	0.0010	0.0011	0.000007
		By Fuel	0.0030	0.0044	0.0029	0.0014	0.000004
		All to INEL	0.0034	0.0052	0.0032	0.0019	0.000004
		All to SRS	0.0024	0.0029	0.0025	0.0007	0.000003
Centralization	INEL		0.0030	0.0028	0.0038	0.0007	0.000003
	SRS		0.0024	0.0026	0.0029	0.0005	0.000002
	HS	Geographic	0.0042	0.0089	0.0020	0.0046	0.000022
		By Fuel	0.0035	0.0048	0.0037	0.0016	0.000006
		All to INEL	0.0038	0.0056	0.0039	0.0020	0.000005
		All to SRS	0.0030	0.0036	0.0035	0.0009	0.000009
	NTS	Geographic	0.0042	0.0089	0.0020	0.0050	0.000024
		By Fuel	0.0039	0.0062	0.0039	0.0024	0.000010
		All to INEL	0.0043	0.0072	0.0041	0.0030	0.000010
		All to SRS	0.0033	0.0045	0.0035	0.0015	0.000009
	ORR	Geographic	0.0030	0.0059	0.0012	0.0030	0.000009
		By Fuel	0.0050	0.0109	0.0031	0.0056	0.000017
		All to INEL	0.0060	0.0137	0.0035	0.0074	0.000024
		All to SRS	0.0033	0.0061	0.0026	0.0026	0.000004

All risks are expressed in latent cancer fatalities during the implementation of the policy, except for the Accidental-Traffic column, which is a number of fatalities.

Table E-25 Tabulation of Overland Transportation Risks: Spent Nuclear Fuel from Developing Nations Only, All Shipment via Truck, Lower Bound Risk Factors

Alternative / Option			Routine				Accidental
Programmatic SNF & INEL EIS Alternative	SNF Site Option	Phase I Approach	Radiological		Nonradiological		Radio-logical
			Crew	Public	Emis.	Traffic	
Decentralization	INEL/SRS		0.0023	0.0072	0.0002	0.0039	0.0000004
1992/1993 Planning Basis	INEL/SRS		0.0023	0.0072	0.0002	0.0039	0.0000004
Regionalization by Fuel Type	INEL/SRS		0.0080	0.0256	0.0010	0.0142	0.0000022
Regionalization by Geography	INEL/SRS		0.0023	0.0072	0.0002	0.0039	0.0000004
	INEL/ORR	Geographic	0.0029	0.0087	0.0003	0.0050	0.0000061
		By Fuel	0.0071	0.0226	0.0009	0.0127	0.0000049
		All to INEL	0.0077	0.0245	0.0011	0.0141	0.0000020
	NTS/SRS	Geographic	0.0026	0.0082	0.0004	0.0046	0.0000031
		By Fuel	0.0073	0.0232	0.0011	0.0130	0.0000064
		All to SRS	0.0058	0.0181	0.0007	0.0096	0.0000018
	NTS/ORR	Geographic	0.0032	0.0098	0.0005	0.0058	0.0000088
		By Fuel	0.0077	0.0244	0.0012	0.0139	0.0000096
		All to INEL	0.0086	0.0273	0.0014	0.0157	0.0000093
		All to SRS	0.0066	0.0202	0.0008	0.0111	0.0000103
	HS/SRS	Geographic	0.0023	0.0073	0.0002	0.0039	0.0000010
		By Fuel	0.0069	0.0221	0.0009	0.0122	0.0000030
		All to SRS	0.0056	0.0173	0.0006	0.0091	0.0000017
	HS/ORR	Geographic	0.0029	0.0088	0.0003	0.0051	0.0000068
		By Fuel	0.0074	0.0233	0.0010	0.0130	0.0000062
		All to INEL	0.0081	0.0260	0.0011	0.0147	0.0000039
		All to SRS	0.0063	0.0194	0.0007	0.0105	0.0000102
Centralization	INEL		0.0090	0.0288	0.0013	0.0164	0.0000023
	SRS		0.0068	0.0212	0.0007	0.0110	0.0000021
	HS	Geographic	0.0063	0.0201	0.0008	0.0112	0.0000215
		By Fuel	0.0100	0.0319	0.0013	0.0177	0.0000143
		All to INEL	0.0098	0.0315	0.0014	0.0176	0.0000043
		All to SRS	0.0106	0.0336	0.0013	0.0184	0.0000320
	NTS	Geographic	0.0060	0.0188	0.0010	0.0113	0.0000255
		By Fuel	0.0098	0.0312	0.0016	0.0180	0.0000189
		All to INEL	0.0098	0.0316	0.0017	0.0181	0.0000096
		All to SRS	0.0101	0.0316	0.0015	0.0183	0.0000352
	ORR	Geographic	0.0045	0.0142	0.0005	0.0080	0.0000140
		By Fuel	0.0095	0.0301	0.0012	0.0170	0.0000185
		All to INEL	0.0108	0.0348	0.0014	0.0200	0.0000232
		All to SRS	0.0074	0.0229	0.0008	0.0122	0.0000105

All risks are expressed in latent cancer fatalities during the implementation of the policy, except for the Accidental-Traffic column, which is a number of fatalities.

Table E-26 Tabulation of Overland Transportation Risks: Spent Nuclear Fuel from Developing Nations Only, Shipments from Ports via Truck, Intersite Shipments via Rail, Lower Bound Risk Factors

Alternative / Option			Routine			Accidental	
Programmatic SNF & INEL EIS Alternative	SNF Site Option	Phase I Approach	Radiological		Nonradiological		Radio-logical
			Crew	Public	Emis.	Traffic	
Decentralization	INEL/SRS						
1992/1993 Planning Basis	INEL/SRS						
Regionalization by Fuel Type	INEL/SRS						
Regionalization	INEL/SRS						
by	INEL/ORR	Geographic	0.0025	0.0078	0.0003	0.0044	0.0000011
Geography		By Fuel	0.0070	0.0221	0.0009	0.0124	0.0000022
		All to INEL	0.0077	0.0245	0.0011	0.0141	0.0000020
	NTS/SRS	Geographic	0.0023	0.0072	0.0004	0.0041	0.0000007
		By Fuel	0.0068	0.0215	0.0010	0.0121	0.0000022
		All to SRS	0.0058	0.0181	0.0007	0.0096	0.0000018
	NTS/ORR	Geographic	0.0026	0.0079	0.0004	0.0046	0.0000014
		By Fuel	0.0071	0.0222	0.0010	0.0126	0.0000027
		All to INEL	0.0078	0.0247	0.0012	0.0143	0.0000027
		All to SRS	0.0061	0.0188	0.0008	0.0101	0.0000028
	HS/SRS	Geographic	0.0021	0.0065	0.0002	0.0035	0.0000006
		By Fuel	0.0066	0.0208	0.0009	0.0115	0.0000023
		All to SRS	0.0056	0.0173	0.0006	0.0091	0.0000017
	HS/ORR	Geographic	0.0024	0.0071	0.0003	0.0041	0.0000014
		By Fuel	0.0069	0.0214	0.0009	0.0121	0.0000027
		All to INEL	0.0076	0.0239	0.0011	0.0137	0.0000028
		All to SRS	0.0059	0.0180	0.0006	0.0096	0.0000026
Centralization	INEL						
	SRS						
	HS	Geographic	0.0042	0.0128	0.0007	0.0069	0.0000054
		By Fuel	0.0086	0.0270	0.0013	0.0149	0.0000051
		All to INEL	0.0092	0.0294	0.0013	0.0166	0.0000031
		All to SRS	0.0077	0.0237	0.0011	0.0125	0.0000083
	NTS	Geographic	0.0040	0.0123	0.0008	0.0071	0.0000052
		By Fuel	0.0084	0.0265	0.0014	0.0150	0.0000050
		All to INEL	0.0091	0.0289	0.0015	0.0167	0.0000030
		All to SRS	0.0076	0.0232	0.0013	0.0126	0.0000081
	ORR	Geographic	0.0035	0.0106	0.0004	0.0057	0.0000029
		By Fuel	0.0080	0.0249	0.0011	0.0137	0.0000053
		All to INEL	0.0088	0.0274	0.0013	0.0154	0.0000063
		All to SRS	0.0069	0.0214	0.0007	0.0112	0.0000030

All risks are expressed in latent cancer fatalities during the implementation of the policy, except for the Accidental-Traffic column, which is a number of fatalities.

Table E-27 Tabulation of Overland Transportation Risks: Spent Nuclear Fuel from Developing Nations Only, All Shipments via Rail, Lower Bound Risk Factors

Alternative / Option			Routine				Accidental
Programmatic SNF & INEL EIS Alternative	SNF Site Option	Phase I Approach	Radiological		Nonradiological		Radio- logical
			Crew	Public	Emis.	Traffic	
Decentralization	INEL/SRS		0.0012	0.0006	0.0004	0.0001	0.0000001
1992/1993 Planning Basis	INEL/SRS		0.0012	0.0006	0.0004	0.0001	0.0000001
Regionalization by Fuel Type	INEL/SRS		0.0023	0.0017	0.0021	0.0005	0.0000003
Regionalization by Geography	INEL/SRS		0.0012	0.0006	0.0004	0.0001	0.0000001
	INEL/ORR	Geographic	0.0015	0.0018	0.0004	0.0006	0.0000007
		By Fuel	0.0024	0.0026	0.0017	0.0009	0.0000006
		All to INEL	0.0024	0.0025	0.0018	0.0009	0.0000002
	NTS/SRS	Geographic	0.0015	0.0017	0.0005	0.0008	0.0000004
		By Fuel	0.0024	0.0026	0.0018	0.0011	0.0000007
		All to SRS	0.0021	0.0027	0.0018	0.0010	0.0000005
	NTS/ORR	Geographic	0.0019	0.0028	0.0006	0.0015	0.0000060
		By Fuel	0.0029	0.0044	0.0020	0.0020	0.0000053
		All to INEL	0.0033	0.0053	0.0022	0.0026	0.0000075
		All to SRS	0.0023	0.0029	0.0019	0.0011	0.0000013
	HS/SRS	Geographic	0.0012	0.0010	0.0004	0.0002	0.0000004
		By Fuel	0.0021	0.0018	0.0017	0.0005	0.0000008
		All to SRS	0.0019	0.0020	0.0016	0.0005	0.0000003
	HS/ORR	Geographic	0.0017	0.0020	0.0005	0.0009	0.0000060
		By Fuel	0.0026	0.0033	0.0018	0.0012	0.0000018
		All to INEL	0.0029	0.0040	0.0019	0.0016	0.0000022
		All to SRS	0.0021	0.0021	0.0017	0.0005	0.0000012
Centralization	INEL		0.0025	0.0017	0.0021	0.0005	0.0000002
	SRS		0.0021	0.0020	0.0021	0.0004	0.0000004
	HS	Geographic	0.0037	0.0080	0.0011	0.0043	0.0000204
		By Fuel	0.0030	0.0036	0.0023	0.0013	0.0000039
		All to INEL	0.0032	0.0042	0.0022	0.0017	0.0000022
		All to SRS	0.0026	0.0026	0.0024	0.0007	0.0000066
	NTS	Geographic	0.0037	0.0077	0.0013	0.0047	0.0000224
		By Fuel	0.0033	0.0046	0.0025	0.0021	0.0000072
		All to INEL	0.0036	0.0054	0.0026	0.0026	0.0000075
		All to SRS	0.0027	0.0032	0.0025	0.0012	0.0000064
	ORR	Geographic	0.0028	0.0055	0.0006	0.0026	0.0000075
		By Fuel	0.0047	0.0101	0.0020	0.0052	0.0000142
		All to INEL	0.0056	0.0128	0.0021	0.0069	0.0000214
		All to SRS	0.0031	0.0056	0.0018	0.0022	0.0000015

All risks are expressed in latent cancer fatalities during the implementation of the policy, except for the Accidental-Traffic column, which is a number of fatalities.

Table E-28 Tabulation of Overland Transportation Risks: Spent Nuclear Fuel from Developing Nations Only, All Shipments via Truck, Upper Bound Risk Factors

Alternative / Option			Routine			Accidental	
Programmatic SNF & INEL EIS Alternative	SNF Site Option	Phase I Approach	Radiological		Nonradiological		Radio-logical
			Crew	Public	Emis.	Traffic	
Decentralization	INEL/SRS		0.0064	0.0191	0.0014	0.0111	0.000014
1992/1993 Planning Basis	INEL/SRS		0.0064	0.0191	0.0014	0.0111	0.000014
Regionalization by Fuel Type	INEL/SRS		0.0113	0.0352	0.0024	0.0220	0.000027
Regionalization	INEL/SRS		0.0064	0.0191	0.0014	0.0111	0.000014
by	INEL/ORR	Geographic	0.0067	0.0200	0.0015	0.0117	0.000019
Geography		By Fuel	0.0104	0.0320	0.0022	0.0199	0.000027
		All to INEL	0.0107	0.0335	0.0021	0.0211	0.000024
	NTS/SRS	Geographic	0.0069	0.0207	0.0016	0.0118	0.000017
		By Fuel	0.0110	0.0340	0.0025	0.0207	0.000029
		All to SRS	0.0099	0.0296	0.0024	0.0176	0.000024
	NTS/ORR	Geographic	0.0072	0.0215	0.0016	0.0125	0.000022
		By Fuel	0.0111	0.0344	0.0025	0.0210	0.000032
		All to INEL	0.0117	0.0368	0.0025	0.0227	0.000032
		All to SRS	0.0104	0.0310	0.0025	0.0186	0.000032
	HS/SRS	Geographic	0.0067	0.0198	0.0014	0.0113	0.000015
		By Fuel	0.0106	0.0329	0.0022	0.0201	0.000025
		All to SRS	0.0097	0.0289	0.0023	0.0173	0.000023
	HS/ORR	Geographic	0.0070	0.0206	0.0015	0.0120	0.000020
		By Fuel	0.0108	0.0333	0.0022	0.0204	0.000028
		All to INEL	0.0113	0.0355	0.0022	0.0220	0.000026
		All to SRS	0.0102	0.0303	0.0024	0.0183	0.000031
Centralization	INEL		0.0120	0.0379	0.0024	0.0240	0.000028
	SRS		0.0106	0.0319	0.0026	0.0192	0.000026
	HS	Geographic	0.0104	0.0320	0.0020	0.0188	0.000038
		By Fuel	0.0134	0.0420	0.0026	0.0257	0.000040
		All to INEL	0.0130	0.0411	0.0025	0.0254	0.000030
		All to SRS	0.0145	0.0445	0.0030	0.0267	0.000057
	NTS	Geographic	0.0102	0.0310	0.0022	0.0189	0.000043
		By Fuel	0.0134	0.0417	0.0029	0.0260	0.000045
		All to INEL	0.0131	0.0415	0.0028	0.0260	0.000036
		All to SRS	0.0141	0.0428	0.0032	0.0267	0.000060
	ORR	Geographic	0.0083	0.0251	0.0017	0.0152	0.000029
		By Fuel	0.0126	0.0393	0.0026	0.0247	0.000042
		All to INEL	0.0137	0.0435	0.0026	0.0275	0.000047
		All to SRS	0.0109	0.0328	0.0026	0.0202	0.000033

All risks are expressed in latent cancer fatalities during the implementation of the policy, except for the Accidental-Traffic column, which is a number of fatalities.

Table E-29 Tabulation of Overland Transportation Risks: Spent Nuclear Fuel from Developing Nations Only, Shipments from Ports via Truck, Intersite Shipments via Rail, Upper Bound Risk Factors

Alternative / Option			Routine			Accidental	
Programmatic SNF & INEL EIS Alternative	SNF Site Option	Phase I Approach	Radiological		Nonradiological		Radio-logical
			Crew	Public	Emis.	Traffic	
Decentralization	INEL/SRS						
1992/1993 Planning Basis	INEL/SRS						
Regionalization by Fuel Type	INEL/SRS						
Regionalization	INEL/SRS						
by	INEL/ORR	Geographic	0.0064	0.0190	0.0014	0.0111	0.000014
Geography		By Fuel	0.0102	0.0315	0.0022	0.0195	0.000024
		All to INEL	0.0107	0.0335	0.0021	0.0211	0.000024
	NTS/SRS	Geographic	0.0067	0.0197	0.0015	0.0113	0.000015
		By Fuel	0.0105	0.0323	0.0023	0.0198	0.000025
		All to SRS	0.0099	0.0296	0.0024	0.0176	0.000024
	NTS/ORR	Geographic	0.0067	0.0196	0.0015	0.0113	0.000015
		By Fuel	0.0105	0.0322	0.0023	0.0198	0.000025
		All to INEL	0.0110	0.0341	0.0023	0.0213	0.000025
		All to SRS	0.0099	0.0296	0.0024	0.0177	0.000024
	HS/SRS	Geographic	0.0065	0.0190	0.0014	0.0110	0.000015
		By Fuel	0.0103	0.0316	0.0022	0.0194	0.000025
		All to SRS	0.0097	0.0289	0.0023	0.0173	0.000023
	HS/ORR	Geographic	0.0065	0.0189	0.0014	0.0110	0.000015
		By Fuel	0.0103	0.0314	0.0022	0.0195	0.000025
		All to INEL	0.0108	0.0334	0.0022	0.0210	0.000025
		All to SRS	0.0097	0.0289	0.0023	0.0173	0.000024
Centralization	INEL						
	SRS						
	HS	Geographic	0.0083	0.0246	0.0019	0.0145	0.000022
		By Fuel	0.0120	0.0371	0.0026	0.0229	0.000030
		All to INEL	0.0124	0.0390	0.0024	0.0244	0.000029
		All to SRS	0.0116	0.0346	0.0029	0.0209	0.000033
	NTS	Geographic	0.0082	0.0245	0.0020	0.0146	0.000023
		By Fuel	0.0120	0.0370	0.0027	0.0231	0.000031
		All to INEL	0.0124	0.0388	0.0026	0.0246	0.000030
		All to SRS	0.0115	0.0345	0.0030	0.0210	0.000033
	ORR	Geographic	0.0073	0.0215	0.0017	0.0129	0.000018
		By Fuel	0.0111	0.0341	0.0025	0.0214	0.000029
		All to INEL	0.0116	0.0361	0.0025	0.0229	0.000030
		All to SRS	0.0104	0.0314	0.0025	0.0192	0.000026

All risks are expressed in latent cancer fatalities during the implementation of the policy, except for the Accidental-Traffic column, which is a number of fatalities.

Table E-30 Tabulation of Overland Transportation Risks: Spent Nuclear Fuel from Developing Nations Only, All Shipments via Rail, Upper Bound Risk Factors

Alternative / Option			Routine				Accidental
Programmatic SNF & INEL EIS Alternative	SNF Site Option	Phase I Approach	Radiological		Nonradiological		Radio-logical
			Crew	Public	Emis.	Traffic	
Decentralization	INEL/SRS		0.0020	0.0025	0.0028	0.0004	0.000005
1992/1993 Planning Basis	INEL/SRS		0.0020	0.0025	0.0028	0.0004	0.000005
Regionalization by Fuel Type	INEL/SRS		0.0030	0.0036	0.0076	0.0007	0.000010
Regionalization by Geography	INEL/SRS		0.0020	0.0025	0.0028	0.0004	0.000005
	INEL/ORR	Geographic	0.0024	0.0037	0.0027	0.0011	0.000006
		By Fuel	0.0031	0.0046	0.0064	0.0013	0.000009
		All to INEL	0.0031	0.0044	0.0076	0.0013	0.000009
	NTS/SRS	Geographic	0.0026	0.0044	0.0029	0.0013	0.000006
		By Fuel	0.0034	0.0053	0.0067	0.0016	0.000010
		All to SRS	0.0032	0.0056	0.0046	0.0015	0.000009
	NTS/ORR	Geographic	0.0029	0.0053	0.0028	0.0019	0.000011
		By Fuel	0.0038	0.0069	0.0067	0.0025	0.000014
		All to INEL	0.0042	0.0078	0.0080	0.0030	0.000017
		All to SRS	0.0033	0.0056	0.0045	0.0015	0.000009
	HS/SRS	Geographic	0.0023	0.0037	0.0028	0.0010	0.000006
		By Fuel	0.0031	0.0046	0.0065	0.0012	0.000010
		All to SRS	0.0030	0.0049	0.0045	0.0012	0.000008
	HS/ORR	Geographic	0.0027	0.0046	0.0027	0.0016	0.000011
		By Fuel	0.0035	0.0059	0.0064	0.0019	0.000011
		All to INEL	0.0038	0.0065	0.0077	0.0023	0.000012
		All to SRS	0.0031	0.0048	0.0044	0.0012	0.000009
Centralization	INEL		0.0031	0.0035	0.0092	0.0007	0.000010
	SRS		0.0029	0.0041	0.0051	0.0007	0.000009
	HS	Geographic	0.0048	0.0107	0.0050	0.0051	0.000027
		By Fuel	0.0039	0.0063	0.0086	0.0020	0.000014
		All to INEL	0.0041	0.0069	0.0098	0.0024	0.000013
		All to SRS	0.0036	0.0055	0.0067	0.0014	0.000016
	NTS	Geographic	0.0048	0.0104	0.0043	0.0052	0.000029
		By Fuel	0.0043	0.0074	0.0080	0.0026	0.000018
		All to INEL	0.0045	0.0082	0.0092	0.0031	0.000019
		All to SRS	0.0038	0.0061	0.0060	0.0017	0.000016
	ORR	Geographic	0.0035	0.0072	0.0030	0.0036	0.000014
		By Fuel	0.0053	0.0118	0.0067	0.0061	0.000024
		All to INEL	0.0062	0.0144	0.0081	0.0078	0.000032
		All to SRS	0.0038	0.0074	0.0046	0.0031	0.000011

All risks are expressed in latent cancer fatalities during the implementation of the policy, except for the Accidental-Traffic column, which is a number of fatalities.

E.8.2 Implementation Alternative - Implementing an Acceptance Policy of Alternative Amounts of Spent Nuclear Fuel - Accept Only from Reactors that Use Highly-Enriched Uranium (HEU)

This alternative was not analyzed for policy reasons. See Chapter 4.

E.8.3 Implementation Alternative - Implementing an Acceptance Policy of Alternative Amounts of Spent Nuclear Fuel - Accept Target Material

Target material is currently stored overseas as a liquid. In order to allow shipment, it must be processed into a solid form by either calcination or oxidation. Calcination results in a solid, but easily crumbled material, and oxidation results in a powder. Oxidation removes the aluminum and, therefore, would lead to fewer shipments than calcination. Shipment counts in Appendix B indicate that just over five shipments would be arriving on the east coast. However, in order to be conservative, six full shipments are used for transportation risk analysis. Similarly, the amount of material that could arrive on the west coast is much less than one full cask. The analysis conservatively assumes one full cask.

Form	Port of Entry		
	East Coast	West Coast	Eastern Canada
Calcinate	14	1	125
Oxidized Powder	6	1	50

Analysis of the target material and potential casks indicates that the maximum dose rate from any cask would be 0.1 mrem per hr at 2 m (3.3 ft). This low radiation level is based on the low burn-up of target material. Because of the conservative release fractions assigned to the oxidized material (see Section E.6.4.2), the results are emphasized below. The risks tabulated in this section would be added to those associated with the basic implementation of Management Alternative 1 if both aspects of the policy were to be performed.

Impacts of Incident-Free Ground Transport

The incident-free transportation of oxidized target material was estimated to result in total latent fatalities that ranged from 0.0002 to 0.003 over the entire duration of the program. The calcinated target material results are 2.5 times higher. These fatalities are the sum of the estimated number of radiation-related LCFs to the public and the crew. This represents an increase to the risk associated with the basic implementation.

The range of fatality estimates is caused by three factors: 1) the option of using truck or rail to transport spent nuclear fuel 2) combinations of Phase 1 and Phase 2 sites that created varying shipment numbers and distances, and 3) the difference between the risk factors for the port-to-site routes.

The estimated number of radiation-related LCFs for transportation workers ranged from 0.00007 to 0.00074. The estimated number of radiation-related LCFs for the general population ranged from 0.00015 to 0.0023, and the estimated number of nonradiological fatalities from vehicular emissions ranged from 0.0001 to 0.00396.

Impacts of Accidents During Ground Transport

The cumulative transportation accident risks over the entire policy are estimated to range from 0.00023 to 0.0054 LCF from radiation and from 0.0001 to 0.013 for traffic fatality, depending on the transportation mode and DOE sites selected. The risks would be four times lower if calcinated material is transported. Both indicate an expectation of less than one fatality.

The impacts of overland transportation are shown in Tables E-31 through E-39. The analysis for this implementation alternative is analogous to the analysis performed for the Basic Implementation (see Section E.7.2), and the interpretation of the tables is the same as described in Section E.7.2. The total policy risk with this implementation alternative is the sum of the values in the above referenced tables and those in Section E.7.2 describing the Basic Implementation.

Table E-40 gives the consequences for the most severe accident hypothesized if that accident were to occur at various locations. The maximum accident risks would be four times lower for calcinated material. The accident probabilities are described in Section 6 of this appendix.

E.8.4 Implementation Alternative - Implementing an Acceptance Policy for Varying Durations - Five-Year Spent Nuclear Fuel Acceptance

Under all SNF&INEL Final EIS (DOE, 1995) alternatives, the shipment of foreign research reactor spent nuclear fuel would require the movement of casks from ports of entry to DOE facilities. The basic shipment count, by point of origin is:

	East Coast		*West Coast*		Totals
	Aluminum	*TRIGA*	*Aluminum*	*TRIGA*	
Phase 1	419	101	105	53	678

Calculated in the same manner as described for the basic implementation of Management Alternative 1, the number of intersite shipments for the two-phased approaches to this strategy varies between 8 and 184. The variation is caused by the wide variety of phased approaches.

Impacts of Incident-Free Ground Transport

The incident-free transportation of spent nuclear fuel was estimated to result in total latent fatalities that ranged from 0.01 to 0.27 over the entire duration of the program. These fatalities are the sum of the estimated number of radiation-related LCFs to the public and the crew.

The range of fatality estimates is caused by two factors: 1) the option of using truck or rail to transport spent nuclear fuel, and 2) the difference between the risk factors for the port-to-site routes.

The estimated number of radiation-related LCFs for transportation workers ranged from 0.005 to 0.064. The estimated number of radiation-related LCFs for the general population ranged from 0.005 to 0.20, and the estimated number of nonradiological fatalities from vehicular emissions ranged from 0.001 to 0.041.

Impacts of Accidents During Ground Transport

The cumulative transportation accident risks over the entire program are estimated to range from 0.000003 to 0.00026 LCFs from radiation and from 0.001 to 0.13 for traffic fatality, depending on the transportation mode and DOE sites selected. Both indicate an expectation of less than one fatality.

The impacts of overland transportation are shown in Tables E-41 through E-49. The analysis for this implementation alternative is analogous to the analysis performed for the basic implementation of Management Alternative 1 (see Section E.7.2), and the interpretation of the tables is the same as described in Section E.7.2.

Table E-31 Tabulation of Overland Transportation Risks: Accept Target Material Only, All Shipments via Truck, Average Risk Factors, Risk Increases over that of the Basic Implementation

Alternative / Option			Routine			Accidental	
Programmatic SNF & INEL EIS Alternative	SNF Site Option	Phase I Approach	Radiological		Nonradiological		Radio-logical
			Crew	Public	Emis.	Traffic	
Decentralization	INEL/SRS		0.00022	0.00061	0.00013	0.0040	0.00070
1992/1993 Planning Basis	INEL/SRS		0.00022	0.00061	0.00013	0.0040	0.00070
Regionalization by Fuel Type	INEL/SRS		0.00023	0.00064	0.00016	0.0041	0.00074
Regionalization	INEL/SRS		0.00022	0.00061	0.00013	0.0040	0.00070
by	INEL/ORR	Geographic	0.00029	0.00079	0.00026	0.0051	0.00071
Geography		By Fuel	0.00030	0.00082	0.00028	0.0053	0.00075
		All to INEL	0.00042	0.00129	0.00060	0.0066	0.00352
	NTS/SRS	Geographic	0.00022	0.00062	0.00015	0.0040	0.00070
		By Fuel	0.00023	0.00064	0.00016	0.0041	0.00074
		All to SRS	0.00023	0.00064	0.00016	0.0041	0.00074
	NTS/ORR	Geographic	0.00029	0.00080	0.00027	0.0052	0.00071
		By Fuel	0.00030	0.00082	0.00028	0.0053	0.00075
		All to INEL	0.00054	0.00166	0.00095	0.0085	0.00353
		All to SRS	0.00030	0.00082	0.00028	0.0053	0.00075
	HS/SRS	Geographic	0.00022	0.00062	0.00015	0.0040	0.00070
		By Fuel	0.00023	0.00064	0.00016	0.0041	0.00074
		All to SRS	0.00023	0.00064	0.00016	0.0041	0.00074
	HS/ORR	Geographic	0.00029	0.00080	0.00027	0.0051	0.00071
		By Fuel	0.00030	0.00082	0.00028	0.0053	0.00075
		All to INEL	0.00051	0.00159	0.00069	0.0079	0.00352
		All to SRS	0.00030	0.00082	0.00028	0.0053	0.00075
Centralization	INEL		0.00049	0.00152	0.00074	0.0075	0.00439
	SRS		0.00023	0.00055	0.00016	0.0041	0.00074
	HS	Geographic	0.00072	0.00221	0.00087	0.0128	0.00163
		By Fuel	0.00073	0.00225	0.00089	0.0131	0.00167
		All to INEL	0.00059	0.00186	0.00086	0.0091	0.00442
		All to SRS	0.00073	0.00225	0.00089	0.0131	0.00167
	NTS	Geographic	0.00067	0.00199	0.00094	0.0127	0.00160
		By Fuel	0.00068	0.00203	0.00096	0.0129	0.00165
		All to INEL	0.00061	0.00191	0.00114	0.0098	0.00439
		All to SRS	0.00068	0.00203	0.00096	0.0129	0.00165
	ORR	Geographic	0.00030	0.00082	0.00027	0.0053	0.00071
		By Fuel	0.00030	0.00082	0.00028	0.0053	0.00075
		All to INEL	0.00073	0.00230	0.00095	0.0128	0.00355
		All to SRS	0.00030	0.00082	0.00028	0.0053	0.00075

All risks are expressed in latent cancer fatalities during the implementation of the policy, except for the Accidental-Traffic column, which is a number of fatalities.

Table E-32 Tabulation of Overland Transportation Risks: Accept Target Material Only, Shipments from Ports via Truck, Intersite Shipments via Rail, Average Risk Factors, Risk Increases over that of the Basic Implementation

Alternative / Option			Routine			Accidental	
			Radiological		Nonradiological		Radio-logical
Programmatic SNF & INEL EIS Alternative	SNF Site Option	Phase I Approach	Crew	Public	Emis.	Traffic	
Decentralization	INEL/SRS						
1992/1993 Planning Basis	INEL/SRS						
Regionalization by Fuel Type	INEL/SRS						
Regionalization by Geography	INEL/SRS						
	INEL/ORR	Geographic	0.00025	0.00062	0.00025	0.0039	0.00070
		By Fuel	0.00026	0.00065	0.00026	0.0040	0.00074
		All to INEL	0.00042	0.00129	0.00060	0.0066	0.00352
	NTS/SRS	Geographic	0.00022	0.00061	0.00015	0.0040	0.00070
		By Fuel	0.00023	0.00064	0.00016	0.0041	0.00074
		All to SRS	0.00023	0.00064	0.00016	0.0041	0.00074
	NTS/ORR	Geographic	0.00025	0.00062	0.00025	0.0039	0.00070
		By Fuel	0.00026	0.00065	0.00026	0.0040	0.00074
		All to INEL	0.00047	0.00132	0.00077	0.0066	0.00352
		All to SRS	0.00026	0.00065	0.00026	0.0040	0.00074
	HS/SRS	Geographic	0.00022	0.00061	0.00015	0.0040	0.00070
		By Fuel	0.00023	0.00064	0.00016	0.0041	0.00074
		All to SRS	0.00023	0.00064	0.00016	0.0041	0.00074
	HS/ORR	Geographic	0.00025	0.00062	0.00025	0.0039	0.00070
		By Fuel	0.00026	0.00065	0.00026	0.0040	0.00074
		All to INEL	0.00046	0.00132	0.00077	0.0066	0.00352
		All to SRS	0.00026	0.00065	0.00026	0.0040	0.00074
Centralization	INEL						
	SRS						
	HS	Geographic	0.00041	0.00097	0.00125	0.0053	0.00161
		By Fuel	0.00041	0.00100	0.00129	0.0054	0.00165
		All to INEL	0.00054	0.00159	0.00094	0.0078	0.00442
		All to SRS	0.00041	0.00100	0.00129	0.0054	0.00165
	NTS	Geographic	0.00040	0.00094	0.00130	0.0054	0.00158
		By Fuel	0.00041	0.00097	0.00133	0.0055	0.00162
		All to INEL	0.00054	0.00157	0.00096	0.0079	0.00439
		All to SRS	0.00041	0.00097	0.00133	0.0055	0.00162
	ORR	Geographic	0.00025	0.00063	0.00026	0.0039	0.00070
		By Fuel	0.00026	0.00065	0.00026	0.0040	0.00074
		All to INEL	0.00050	0.00136	0.00115	0.0068	0.00353
		All to SRS	0.00026	0.00065	0.00026	0.0040	0.00074

All risks are expressed in latent cancer fatalities during the implementation of the policy, except for the Accidental-Traffic column, which is a number of fatalities.

Table E-33 Tabulation of Overland Transportation Risks: Accept Target Material Only, All Shipments via Rail, Average Risk Factors, Risk Increases over that of the Basic Implementation

Alternative / Option			Routine			Accidental	
Programmatic SNF & INEL EIS Alternative	SNF Site Option	Phase I Approach	Radiological		Nonradiological		Radio-logical
			Crew	Public	Emis.	Traffic	
Decentralization	INEL/SRS		0.00007	0.00018	0.00228	0.0001	0.00023
1992/1993 Planning Basis	INEL/SRS		0.00007	0.00018	0.00228	0.0001	0.00023
Regionalization by Fuel Type	INEL/SRS		0.00007	0.00019	0.00295	0.0001	0.00024
Regionalization	INEL/SRS		0.00007	0.00018	0.00228	0.0001	0.00023
by	INEL/ORR	Geographic	0.00010	0.00019	0.00267	0.0002	0.00021
Geography		By Fuel	0.00010	0.00019	0.00270	0.0002	0.00022
		All to INEL	0.00010	0.00016	0.00217	0.0002	0.00085
	NTS/SRS	Geographic	0.00007	0.00018	0.00292	0.0001	0.00023
		By Fuel	0.00007	0.00019	0.00295	0.0001	0.00024
		All to SRS	0.00007	0.00019	0.00295	0.0001	0.00024
	NTS/ORR	Geographic	0.00014	0.00036	0.00269	0.0014	0.00022
		By Fuel	0.00010	0.00019	0.00270	0.0002	0.00022
		All to INEL	0.00022	0.00052	0.00253	0.0022	0.00086
		All to SRS	0.00010	0.00019	0.00270	0.0002	0.00022
	HS/SRS	Geographic	0.00007	0.00018	0.00292	0.0001	0.00023
		By Fuel	0.00007	0.00019	0.00295	0.0001	0.00024
		All to SRS	0.00007	0.00019	0.00295	0.0001	0.00024
	HS/ORR	Geographic	0.00014	0.00036	0.00269	0.0014	0.00022
		By Fuel	0.00010	0.00019	0.00270	0.0002	0.00022
		All to INEL	0.00019	0.00045	0.00227	0.0016	0.00085
		All to SRS	0.00010	0.00019	0.00270	0.0002	0.00022
Centralization	INEL		0.00012	0.00016	0.00239	0.0003	0.00106
	SRS		0.00007	0.00015	0.00295	0.0001	0.00024
	HS	Geographic	0.00050	0.00151	0.00337	0.0080	0.00047
		By Fuel	0.00020	0.00029	0.00381	0.0005	0.00046
		All to INEL	0.00021	0.00047	0.00251	0.0016	0.00107
		All to SRS	0.00020	0.00029	0.00381	0.0005	0.00046
	NTS	Geographic	0.00046	0.00131	0.00343	0.0077	0.00047
		By Fuel	0.00019	0.00028	0.00384	0.0004	0.00046
		All to INEL	0.00024	0.00054	0.00278	0.0022	0.00107
		All to SRS	0.00019	0.00028	0.00384	0.0004	0.00046
	ORR	Geographic	0.00014	0.00036	0.00270	0.0014	0.00022
		By Fuel	0.00010	0.00019	0.00270	0.0002	0.00022
		All to INEL	0.00041	0.00117	0.00253	0.0064	0.00087
		All to SRS	0.00010	0.00019	0.00270	0.0002	0.00022

All risks are expressed in latent cancer fatalities during the implementation of the policy, except for the Accidental-Traffic column, which is a number of fatalities.

Table E-34 Tabulation of Overland Transportation Risks: Accept Target Material Only, All Shipments via Truck, Lower Bound Risk Factors, Risk Increases over that of the Basic Implementation

Alternative / Option			Routine			Accidental	
Programmatic SNF & INEL EIS Alternative	SNF Site Option	Phase I Approach	Radiological		Nonradiological		Radio-logical
			Crew	Public	Emis.	Traffic	
Decentralization	INEL/SRS		0.00021	0.00060	0.00013	0.0039	0.00068
1992/1993 Planning Basis	INEL/SRS		0.00021	0.00060	0.00013	0.0039	0.00068
Regionalization by Fuel Type	INEL/SRS		0.00022	0.00062	0.00014	0.0040	0.00070
Regionalization by Geography	INEL/SRS		0.00021	0.00060	0.00013	0.0039	0.00068
	INEL/ORR	Geographic	0.00028	0.00078	0.00025	0.0050	0.00095
		By Fuel	0.00029	0.00081	0.00026	0.0052	0.00098
		All to INEL	0.00041	0.00126	0.00058	0.0064	0.00341
	NTS/SRS	Geographic	0.00022	0.00060	0.00014	0.0039	0.00069
		By Fuel	0.00022	0.00062	0.00014	0.0040	0.00070
		All to SRS	0.00022	0.00062	0.00014	0.0040	0.00070
	NTS/ORR	Geographic	0.00029	0.00079	0.00026	0.0050	0.00096
		By Fuel	0.00029	0.00081	0.00026	0.0052	0.00098
		All to INEL	0.00053	0.00163	0.00093	0.0083	0.00358
		All to SRS	0.00029	0.00081	0.00026	0.0052	0.00098
	HS/SRS	Geographic	0.00022	0.00060	0.00013	0.0039	0.00069
		By Fuel	0.00022	0.00062	0.00014	0.0040	0.00070
		All to SRS	0.00022	0.00062	0.00014	0.0040	0.00070
	HS/ORR	Geographic	0.00029	0.00079	0.00025	0.0050	0.00096
		By Fuel	0.00029	0.00081	0.00026	0.0052	0.00098
		All to INEL	0.00050	0.00156	0.00067	0.0077	0.00356
		All to SRS	0.00029	0.00081	0.00026	0.0052	0.00098
Centralization	INEL		0.00048	0.00147	0.00072	0.0073	0.00426
	SRS		0.00022	0.00062	0.00014	0.0040	0.00070
	HS	Geographic	0.00071	0.00219	0.00085	0.0127	0.00369
		By Fuel	0.00073	0.00224	0.00087	0.0130	0.00375
		All to INEL	0.00058	0.00183	0.00084	0.0089	0.00443
		All to SRS	0.00073	0.00224	0.00087	0.0130	0.00375
	NTS	Geographic	0.00066	0.00197	0.00093	0.0125	0.00362
		By Fuel	0.00068	0.00201	0.00094	0.0128	0.00369
		All to INEL	0.00060	0.00188	0.00111	0.0095	0.00442
		All to SRS	0.00068	0.00201	0.00094	0.0128	0.00369
	ORR	Geographic	0.00029	0.00080	0.00026	0.0051	0.00100
		By Fuel	0.00029	0.00081	0.00026	0.0052	0.00098
		All to INEL	0.00072	0.00227	0.00093	0.0126	0.00528
		All to SRS	0.00029	0.00081	0.00026	0.0052	0.00098

All risks are expressed in latent cancer fatalities during the implementation of the policy, except for the Accidental-Traffic column, which is a number of fatalities.

Table E-35 Tabulation of Overland Transportation Risks: Accept Target Material Only, Shipments from Ports via Truck, Intersite via Rail, Lower Bound Risk Factors, Risk Increases over that of the Basic Implementation

Alternative / Option			Routine			Accidental	
Programmatic SNF & INEL EIS Alternative	SNF Site Option	Phase I Approach	Radiological		Nonradiological		Radio- logical
			Crew	Public	Emis.	Traffic	
Decentralization	INEL/SRS						
1992/1993 Planning Basis	INEL/SRS						
Regionalization by Fuel Type	INEL/SRS						
Regionalization	INEL/SRS						
by	INEL/ORR	Geographic	0.00024	0.00061	0.00023	0.0038	0.00071
Geography		By Fuel	0.00025	0.00063	0.00024	0.0039	0.00073
		All to INEL	0.00041	0.00126	0.00058	0.0064	0.00341
	NTS/SRS	Geographic	0.00022	0.00060	0.00014	0.0039	0.00068
		By Fuel	0.00022	0.00062	0.00014	0.0040	0.00070
		All to SRS	0.00022	0.00062	0.00014	0.0040	0.00070
	NTS/ORR	Geographic	0.00025	0.00061	0.00024	0.0038	0.00071
		By Fuel	0.00025	0.00063	0.00024	0.0039	0.00073
		All to INEL	0.00046	0.00129	0.00075	0.0065	0.00343
		All to SRS	0.00025	0.00063	0.00024	0.0039	0.00073
	HS/SRS	Geographic	0.00022	0.00060	0.00014	0.0039	0.00068
		By Fuel	0.00022	0.00062	0.00014	0.0040	0.00070
		All to SRS	0.00022	0.00062	0.00014	0.0040	0.00070
	HS/ORR	Geographic	0.00025	0.00061	0.00024	0.0038	0.00071
		By Fuel	0.00025	0.00063	0.00024	0.0039	0.00073
		All to INEL	0.00045	0.00129	0.00075	0.0064	0.00344
		All to SRS	0.00025	0.00063	0.00024	0.0039	0.00073
Centralization	INEL						
	SRS						
	HS	Geographic	0.00040	0.00096	0.00124	0.0052	0.00194
		By Fuel	0.00041	0.00098	0.00127	0.0053	0.00197
		All to INEL	0.00053	0.00156	0.00091	0.0076	0.00432
		All to SRS	0.00041	0.00098	0.00127	0.0053	0.00197
	NTS	Geographic	0.00039	0.00092	0.00129	0.0052	0.00188
		By Fuel	0.00040	0.00095	0.00131	0.0054	0.00190
		All to INEL	0.00053	0.00154	0.00093	0.0077	0.00426
		All to SRS	0.00040	0.00095	0.00131	0.0054	0.00190
	ORR	Geographic	0.00025	0.00061	0.00025	0.0038	0.00072
		By Fuel	0.00025	0.00063	0.00024	0.0039	0.00073
		All to INEL	0.00049	0.00132	0.00113	0.0066	0.00376
		All to SRS	0.00025	0.00063	0.00024	0.0039	0.00073

All risks are expressed in latent cancer fatalities during the implementation of the policy, except for the Accidental-Traffic column, which is a number of fatalities.

Table E-36 Tabulation of Overland Transportation Risks: Accept Target Material Only, All Shipments via Rail, Lower Bound Risk Factors, Risk Increases over that of the Basic Implementation

Alternative / Option			Routine			Accidental	
Programmatic SNF & INEL EIS Alternative	SNF Site Option	Phase I Approach	Radiological		Nonradiological		Radio-logical
			Crew	Public	Emis.	Traffic	
Decentralization	INEL/SRS		0.00007	0.00018	0.00289	0.0001	0.00023
1992/1993 Planning Basis	INEL/SRS		0.00007	0.00018	0.00289	0.0001	0.00023
Regionalization by Fuel Type	INEL/SRS		0.00007	0.00018	0.00292	0.0001	0.00023
Regionalization by Geography	INEL/SRS		0.00007	0.00018	0.00289	0.0001	0.00023
	INEL/ORR	Geographic	0.00010	0.00019	0.00264	0.0002	0.00023
		By Fuel	0.00010	0.00019	0.00267	0.0002	0.00024
		All to INEL	0.00010	0.00015	0.00210	0.0002	0.00080
	NTS/SRS	Geographic	0.00007	0.00018	0.00289	0.0001	0.00023
		By Fuel	0.00007	0.00018	0.00292	0.0001	0.00023
		All to SRS	0.00007	0.00018	0.00292	0.0001	0.00023
	NTS/ORR	Geographic	0.00014	0.00036	0.00267	0.0014	0.00048
		By Fuel	0.00010	0.00019	0.00267	0.0002	0.00024
		All to INEL	0.00022	0.00052	0.00245	0.0022	0.00097
		All to SRS	0.00010	0.00019	0.00267	0.0002	0.00024
	HS/SRS	Geographic	0.00007	0.00018	0.00289	0.0001	0.00023
		By Fuel	0.00007	0.00018	0.00292	0.0001	0.00023
		All to SRS	0.00007	0.00018	0.00292	0.0001	0.00023
	HS/ORR	Geographic	0.00014	0.00036	0.00267	0.0014	0.00048
		By Fuel	0.00010	0.00019	0.00267	0.0002	0.00024
		All to INEL	0.00019	0.00045	0.00219	0.0016	0.00095
		All to SRS	0.00010	0.00019	0.00267	0.0002	0.00024
Centralization	INEL		0.00011	0.00017	0.00231	0.0003	0.00100
	SRS		0.00007	0.00018	0.00292	0.0001	0.00023
	HS	Geographic	0.00050	0.00150	0.00333	0.0080	0.00255
		By Fuel	0.00020	0.00028	0.00377	0.0005	0.00082
		All to INEL	0.00020	0.00046	0.00243	0.0016	0.00116
		All to SRS	0.00020	0.00028	0.00377	0.0005	0.00082
	NTS	Geographic	0.00046	0.00131	0.00339	0.0077	0.00251
		By Fuel	0.00019	0.00027	0.00380	0.0004	0.00079
		All to INEL	0.00023	0.00054	0.00269	0.0022	0.00117
		All to SRS	0.00019	0.00027	0.00380	0.0004	0.00079
	ORR	Geographic	0.00014	0.00036	0.00267	0.0014	0.00049
		By Fuel	0.00010	0.00019	0.00267	0.0002	0.00024
		All to INEL	0.00041	0.00116	0.00245	0.0064	0.00266
		All to SRS	0.00010	0.00019	0.00267	0.0002	0.00024

All risks are expressed in latent cancer fatalities during the implementation of the policy, except for the Accidental-Traffic column, which is a number of fatalities.

Table E-37 Tabulation of Overland Transportation Risks: Accept Target Material Only, All Shipments via Truck, Upper Bound Risk Factors, Risk Increases over that of the Basic Implementation

Alternative / Option			Routine			Accidental	
			Radiological		Nonradiological		Radio-
Programmatic SNF & INEL EIS Alternative	SNF Site Option	Phase I Approach	Crew	Public	Emis.	Traffic	logical
Decentralization	INEL/SRS		0.00024	0.00066	0.00019	0.0042	0.00074
1992/1993 Planning Basis	INEL/SRS		0.00024	0.00066	0.00019	0.0042	0.00074
Regionalization by Fuel Type	INEL/SRS		0.00024	0.00068	0.00021	0.0044	0.00080
Regionalization	INEL/SRS		0.00024	0.00066	0.00019	0.0042	0.00074
by	INEL/ORR	Geographic	0.00030	0.00084	0.00030	0.0053	0.00100
Geography		By Fuel	0.00031	0.00086	0.00033	0.0055	0.00107
		All to INEL	0.00043	0.00131	0.00062	0.0067	0.00355
	NTS/SRS	Geographic	0.00024	0.00066	0.00019	0.0043	0.00074
		By Fuel	0.00024	0.00068	0.00021	0.0044	0.00080
		All to SRS	0.00024	0.00068	0.00021	0.0044	0.00080
	NTS/ORR	Geographic	0.00031	0.00084	0.00031	0.0054	0.00101
		By Fuel	0.00031	0.00086	0.00033	0.0055	0.00107
		All to INEL	0.00054	0.00167	0.00098	0.0086	0.00372
		All to SRS	0.00031	0.00086	0.00033	0.0055	0.00107
	HS/SRS	Geographic	0.00024	0.00066	0.00019	0.0042	0.00074
		By Fuel	0.00024	0.00068	0.00021	0.0044	0.00080
		All to SRS	0.00024	0.00068	0.00021	0.0044	0.00080
	HS/ORR	Geographic	0.00031	0.00084	0.00031	0.0054	0.00101
		By Fuel	0.00031	0.00086	0.00033	0.0055	0.00107
		All to INEL	0.00051	0.00160	0.00072	0.0081	0.00370
		All to SRS	0.00031	0.00086	0.00033	0.0055	0.00107
Centralization	INEL		0.00049	0.00152	0.00077	0.0076	0.00442
	SRS		0.00024	0.00068	0.00021	0.0044	0.00080
	HS	Geographic	0.00073	0.00224	0.00091	0.0131	0.00376
		By Fuel	0.00074	0.00229	0.00094	0.0134	0.00387
		All to INEL	0.00059	0.00187	0.00088	0.0093	0.00459
		All to SRS	0.00074	0.00229	0.00094	0.0134	0.00387
	NTS	Geographic	0.00068	0.00203	0.00098	0.0129	0.00371
		By Fuel	0.00070	0.00207	0.00101	0.0131	0.00381
		All to INEL	0.00062	0.00192	0.00116	0.0099	0.00459
		All to SRS	0.00070	0.00207	0.00101	0.0131	0.00381
	ORR	Geographic	0.00031	0.00086	0.00031	0.0055	0.00105
		By Fuel	0.00031	0.00086	0.00033	0.0055	0.00107
		All to INEL	0.00074	0.00231	0.00098	0.0129	0.00541
		All to SRS	0.00031	0.00086	0.00033	0.0055	0.00107

All risks are expressed in latent cancer fatalities during the implementation of the policy, except for the Accidental-Traffic column, which is a number of fatalities.

Table E-38 Tabulation of Overland Transportation Risks: Accept Target Material Only, Shipments from Ports via Truck, Intersite Shipments via Rail, Upper Bound Risk Factors, Risk Increases over that of the Basic Implementation

Alternative / Option			Routine			Accidental	
			Radiological		Nonradiological		Radio-
Programmatic SNF & INEL EIS Alternative	SNF Site Option	Phase I Approach	Crew	Public	Emis.	Traffic	logical
Decentralization	INEL/SRS						
1992/1993 Planning Basis	INEL/SRS						
Regionalization by Fuel Type	INEL/SRS						
Regionalization	INEL/SRS						
by	INEL/ORR	Geographic	0.00026	0.00067	0.00028	0.0041	0.00076
Geography		By Fuel	0.00027	0.00069	0.00031	0.0043	0.00082
		All to INEL	0.00043	0.00131	0.00062	0.0067	0.00355
	NTS/SRS	Geographic	0.00024	0.00066	0.00019	0.0042	0.00074
		By Fuel	0.00024	0.00068	0.00021	0.0044	0.00080
		All to SRS	0.00024	0.00068	0.00021	0.0044	0.00080
	NTS/ORR	Geographic	0.00027	0.00067	0.00029	0.0041	0.00076
		By Fuel	0.00027	0.00069	0.00031	0.0043	0.00082
		All to INEL	0.00047	0.00133	0.00080	0.0068	0.00357
		All to SRS	0.00027	0.00069	0.00031	0.0043	0.00082
	HS/SRS	Geographic	0.00024	0.00066	0.00019	0.0042	0.00074
		By Fuel	0.00024	0.00068	0.00021	0.0044	0.00080
		All to SRS	0.00024	0.00068	0.00021	0.0044	0.00080
	HS/ORR	Geographic	0.00027	0.00067	0.00029	0.0041	0.00076
		By Fuel	0.00027	0.00069	0.00031	0.0043	0.00082
		All to INEL	0.00047	0.00133	0.00080	0.0068	0.00358
		All to SRS	0.00027	0.00069	0.00031	0.0043	0.00082
Centralization	INEL						
	SRS						
	HS	Geographic	0.00042	0.00101	0.00129	0.0055	0.00201
		By Fuel	0.00043	0.00104	0.00133	0.0057	0.00208
		All to INEL	0.00055	0.00160	0.00096	0.0080	0.00448
		All to SRS	0.00043	0.00104	0.00133	0.0057	0.00208
	NTS	Geographic	0.00041	0.00098	0.00134	0.0056	0.00196
		By Fuel	0.00042	0.00100	0.00138	0.0058	0.00203
		All to INEL	0.00054	0.00158	0.00098	0.0081	0.00444
		All to SRS	0.00042	0.00100	0.00138	0.0058	0.00203
	ORR	Geographic	0.00027	0.00067	0.00030	0.0041	0.00077
		By Fuel	0.00027	0.00069	0.00031	0.0043	0.00082
		All to INEL	0.00051	0.00137	0.00118	0.0069	0.00390
		All to SRS	0.00027	0.00069	0.00031	0.0043	0.00082

All risks are expressed in latent cancer fatalities during the implementation of the policy, except for the Accidental-Traffic column, which is a number of fatalities.

Table E-39 Tabulation of Overland Transportation Risks: Accept Target Material Only, All Shipments via Rail, Upper Bound Risk Factors, Risk Increases over that of the Basic Implementation

Alternative / Option			Routine			Accidental	
Programmatic SNF & INEL EIS Alternative	SNF Site Option	Phase I Approach	Radiological Crew	Radiological Public	Nonradiological Emis.	Nonradiological Traffic	Radiological
Decentralization	INEL/SRS		0.00008	0.00019	0.00301	0.0002	0.00025
1992/1993 Planning Basis	INEL/SRS		0.00008	0.00019	0.00301	0.0002	0.00025
Regionalization by Fuel Type	INEL/SRS		0.00008	0.00019	0.00305	0.0002	0.00026
Regionalization	INEL/SRS		0.00008	0.00019	0.00301	0.0002	0.00025
by	INEL/ORR	Geographic	0.00010	0.00019	0.00276	0.0002	0.00025
Geography		By Fuel	0.00011	0.00020	0.00280	0.0002	0.00026
		All to INEL	0.00010	0.00016	0.00242	0.0002	0.00089
	NTS/SRS	Geographic	0.00008	0.00019	0.00302	0.0002	0.00025
		By Fuel	0.00008	0.00019	0.00305	0.0002	0.00026
		All to SRS	0.00008	0.00019	0.00305	0.0002	0.00026
	NTS/ORR	Geographic	0.00015	0.00037	0.00278	0.0014	0.00050
		By Fuel	0.00011	0.00020	0.00280	0.0002	0.00026
		All to INEL	0.00022	0.00053	0.00278	0.0022	0.00106
		All to SRS	0.00011	0.00020	0.00280	0.0002	0.00026
	HS/SRS	Geographic	0.00008	0.00019	0.00302	0.0002	0.00025
		By Fuel	0.00008	0.00019	0.00305	0.0002	0.00026
		All to SRS	0.00008	0.00019	0.00305	0.0002	0.00026
	HS/ORR	Geographic	0.00015	0.00037	0.00278	0.0014	0.00050
		By Fuel	0.00011	0.00020	0.00280	0.0002	0.00026
		All to INEL	0.00019	0.00045	0.00252	0.0016	0.00104
		All to SRS	0.00011	0.00020	0.00280	0.0002	0.00026
Centralization	INEL		0.00012	0.00018	0.00268	0.0003	0.00111
	SRS		0.00008	0.00019	0.00305	0.0002	0.00026
	HS	Geographic	0.00051	0.00151	0.00352	0.0080	0.00258
		By Fuel	0.00020	0.00029	0.00396	0.0005	0.00086
		All to INEL	0.00021	0.00047	0.00282	0.0016	0.00127
		All to SRS	0.00020	0.00029	0.00396	0.0005	0.00086
	NTS	Geographic	0.00046	0.00132	0.00354	0.0077	0.00255
		By Fuel	0.00019	0.00028	0.00396	0.0005	0.00082
		All to INEL	0.00024	0.00055	0.00306	0.0022	0.00128
		All to SRS	0.00019	0.00028	0.00396	0.0005	0.00082
	ORR	Geographic	0.00015	0.00037	0.00279	0.0014	0.00050
		By Fuel	0.00011	0.00020	0.00280	0.0002	0.00026
		All to INEL	0.00041	0.00117	0.00278	0.0064	0.00275
		All to SRS	0.00011	0.00020	0.00280	0.0002	0.00026

All risks are expressed in latent cancer fatalities during the implementation of the policy, except for the Accidental-Traffic column, which is a number of fatalities.

Table E-40 Potential Consequences for the Most Severe Accidents Involving Shipments of Target Material[a,b]

Mode and Accident Location	Neutral Conditions[c]				Stable Conditions[d]			
	Population[e]		MEI[f]		Population[e]		MEI[f]	
	Dose (person-rem)	Consequences (LCF)	Dose (rem)	Consequences (LCF)	Dose (person-rem)	Consequences (LCF)	Dose (person-rem)	Consequences (LCF)
Truck:								
Urban	206	0.1	0.15	0.000074	1650	0.83	0.50	0.00025
Suburban	38.3	0.019	0.15	0.000074	307	0.15	0.50	0.00025
Rural	0.70	0.00035	0.15	0.000074	5.5	0.0028	0.50	0.00025
Rail:								
Urban	206	0.1	0.15	0.000074	1650	0.83	0.50	0.00025
Suburban	38.3	0.19	0.15	0.000074	307	0.15	0.50	0.00025
Rural	0.70	0.00035	0.15	0.000074	5.5	0.0028	0.50	0.00025

[a] *The most severe accidents correspond to modal study accident severity category 6 (DOE, 1994b).*

[b] *Buoyant plume rise resulting from fire for a severe accident was included in the exposure model.*

[c] *Neutral weather conditions result in moderate dispersion and dilution of the release plume. Neutral conditions were taken to be Pasquill stability Class D with a wind speed of 4 m per sec (9 mph). Neutral conditions occur approximately 50 percent of the time in the United States.*

[d] *Stable weather conditions result in minimal dispersion and dilution of the release plume and are thus unfavorable. Stable conditions were taken to be Pasquill stability Class F with a wind speed of 1 m per sec (2.2 mph). Stable conditions occur approximately one-third of the time in the United States.*

[e] *Populations extend at a uniform population density to a radius of 80 km (50 mi) from the accident site. Population exposure pathways include acute inhalation, acute cloudshine, groundshine, resuspended inhalation, resuspended cloudshine, and ingestion of food, including initially contaminated food (rural only). No decontamination or mitigative actions are taken.*

[f] *The MEI is assumed to be at the location of maximum exposure. The locations of maximum exposure would be 160 m (528 ft) and 400 m (1,320 ft) from the accident site under neutral and stable atmospheric conditions, respectively. Individual exposure pathways include acute inhalation, acute cloudshine, and groundshine during passage of the plume. No ingested dose is considered.*

E.8.5 Implementation Alternative - Implementing an Acceptance Policy for Varying Durations - Indefinite HEU Acceptance

Since most LEU would come back within 10 years and spent nuclear fuel produced from the indefinite operation of HEU reactors is difficult to predict, it is reasonable to assume that the analysis for the basic implementation applies closely.

E.8.6 Implementation Alternative - Implementing an Acceptance Policy with Varying Financial Approaches

None of the financial approaches would have a significant effect on overland transportation. The effects calculated for the basic implementation adequately model this strategy.

Table E-41 Tabulation of Overland Transportation Risks: Five-Year Spent Nuclear Fuel Acceptance Only, All Shipments via Truck, Average Risk Factors

Alternative / Option			Routine			Accidental	
Programmatic SNF & INEL EIS Alternative	SNF Site Option	Phase I Approach	Radiological		Nonradiological		Radio-logical
			Crew	Public	Emis.	Traffic	
Decentralization	INEL/SRS		0.015	0.045	0.002	0.028	0.000013
1992/1993 Planning Basis	INEL/SRS		0.015	0.045	0.002	0.028	0.000013
Regionalization by Fuel Type	INEL/SRS		0.030	0.093	0.004	0.056	0.000032
Regionalization	INEL/SRS		0.015	0.045	0.002	0.028	0.000013
by	INEL/ORR	Geographic	0.017	0.051	0.002	0.032	0.000046
Geography		By Fuel	0.032	0.099	0.005	0.060	0.000066
		All to INEL	0.050	0.157	0.008	0.090	0.000055
	NTS/SRS	Geographic	0.016	0.049	0.002	0.030	0.000022
		By Fuel	0.031	0.096	0.005	0.058	0.000041
		All to SRS	0.027	0.082	0.004	0.050	0.000029
	NTS/ORR	Geographic	0.018	0.055	0.003	0.034	0.000055
		By Fuel	0.033	0.102	0.005	0.062	0.000074
		All to INEL	0.054	0.171	0.009	0.097	0.000092
		All to SRS	0.030	0.090	0.005	0.055	0.000072
	HS/SRS	Geographic	0.016	0.048	0.002	0.030	0.000016
		By Fuel	0.031	0.095	0.005	0.057	0.000035
		All to SRS	0.027	0.082	0.004	0.050	0.000029
	HS/ORR	Geographic	0.018	0.054	0.002	0.033	0.000049
		By Fuel	0.033	0.101	0.005	0.061	0.000068
		All to INEL	0.053	0.168	0.008	0.095	0.000065
		All to SRS	0.030	0.090	0.005	0.055	0.000072
Centralization	INEL		0.050	0.157	0.008	0.090	0.000055
	SRS		0.027	0.082	0.004	0.050	0.000029
	HS	Geographic	0.029	0.088	0.004	0.053	0.000133
		By Fuel	0.044	0.136	0.006	0.081	0.000153
		All to INEL	0.053	0.168	0.008	0.095	0.000065
		All to SRS	0.044	0.134	0.006	0.081	0.000183
	NTS	Geographic	0.028	0.083	0.004	0.053	0.000152
		By Fuel	0.043	0.130	0.007	0.081	0.000172
		All to INEL	0.054	0.171	0.009	0.097	0.000092
		All to SRS	0.042	0.127	0.006	0.080	0.000199
	ORR	Geographic	0.020	0.060	0.003	0.038	0.000071
		By Fuel	0.035	0.108	0.005	0.065	0.000090
		All to INEL	0.061	0.195	0.009	0.114	0.000162
		All to SRS	0.030	0.090	0.005	0.055	0.000072

All risks are expressed in latent cancer fatalities during the implementation of the policy, except for the Accidental-Traffic column, which is a number of fatalities.

Table E-42 Tabulation of Overland Transportation Risks: Five-Year Spent Nuclear Fuel Acceptance Only, Shipments from Ports via Truck, Intersite Shipments via Rail, Average Risk Factors

Alternative / Option			Routine			Accidental	
Programmatic SNF & INEL EIS Alternative	SNF Site Option	Phase I Approach	Radiological		Nonradiological		Radio-logical
			Crew	Public	Emis.	Traffic	
Decentralization	INEL/SRS						
1992/1993 Planning Basis	INEL/SRS						
Regionalization by Fuel Type	INEL/SRS						
Regionalization by Geography	INEL/SRS						
	INEL/ORR	Geographic	0.016	0.046	0.002	0.028	0.000017
		By Fuel	0.031	0.093	0.005	0.056	0.000036
		All to INEL	0.050	0.157	0.008	0.090	0.000055
	NTS/SRS	Geographic	0.015	0.046	0.002	0.028	0.000014
		By Fuel	0.030	0.093	0.004	0.056	0.000033
		All to SRS	0.027	0.082	0.004	0.050	0.000029
	NTS/ORR	Geographic	0.016	0.046	0.002	0.028	0.000017
		By Fuel	0.031	0.093	0.005	0.056	0.000037
		All to INEL	0.050	0.157	0.008	0.090	0.000058
		All to SRS	0.028	0.083	0.004	0.050	0.000033
	HS/SRS	Geographic	0.015	0.046	0.002	0.028	0.000014
		By Fuel	0.030	0.093	0.004	0.056	0.000033
		All to SRS	0.027	0.082	0.004	0.050	0.000029
	HS/ORR	Geographic	0.016	0.046	0.002	0.028	0.000018
		By Fuel	0.031	0.093	0.005	0.056	0.000037
		All to INEL	0.050	0.157	0.008	0.090	0.000059
		All to SRS	0.028	0.083	0.004	0.050	0.000033
Centralization	INEL						
	SRS						
	HS	Geographic	0.017	0.047	0.003	0.029	0.000039
		By Fuel	0.032	0.094	0.006	0.057	0.000058
		All to INEL	0.050	0.157	0.008	0.090	0.000059
		All to SRS	0.029	0.084	0.006	0.050	0.000061
	NTS	Geographic	0.017	0.047	0.003	0.029	0.000037
		By Fuel	0.032	0.094	0.006	0.056	0.000057
		All to INEL	0.050	0.157	0.008	0.090	0.000058
		All to SRS	0.029	0.084	0.006	0.050	0.000060
	ORR	Geographic	0.016	0.046	0.002	0.028	0.000022
		By Fuel	0.031	0.093	0.005	0.056	0.000041
		All to INEL	0.051	0.158	0.008	0.090	0.000076
		All to SRS	0.028	0.083	0.004	0.050	0.000033

All risks are expressed in latent cancer fatalities during the implementation of the policy, except for the Accidental-Traffic column, which is a number of fatalities.

Table E-43 Tabulation of Overland Transportation Risks: Five-Year Spent Nuclear Fuel Acceptance Only, All Shipments via Rail, Average Risk Factors

Alternative / Option			Routine			Accidental	
Programmatic SNF & INEL EIS Alternative	SNF Site Option	Phase I Approach	Radiological		Nonradiological		Radio-logical
			Crew	Public	Emis.	Traffic	
Decentralization	INEL/SRS		0.006	0.007	0.009	0.001	0.000005
1992/1993 Planning Basis	INEL/SRS		0.006	0.007	0.009	0.001	0.000005
Regionalization by Fuel Type	INEL/SRS		0.009	0.011	0.015	0.002	0.000010
Regionalization by Geography	INEL/SRS		0.006	0.007	0.009	0.001	0.000005
	INEL/ORR	Geographic	0.007	0.007	0.009	0.001	0.000008
		By Fuel	0.010	0.012	0.015	0.002	0.000013
		All to INEL	0.013	0.013	0.018	0.003	0.000013
	NTS/SRS	Geographic	0.006	0.007	0.009	0.001	0.000006
		By Fuel	0.009	0.011	0.015	0.002	0.000011
		All to SRS	0.009	0.011	0.014	0.002	0.000010
	NTS/ORR	Geographic	0.009	0.013	0.009	0.005	0.000039
		By Fuel	0.011	0.015	0.015	0.004	0.000022
		All to INEL	0.017	0.027	0.020	0.010	0.000050
		All to SRS	0.009	0.011	0.014	0.002	0.000014
	HS/SRS	Geographic	0.006	0.007	0.009	0.001	0.000006
		By Fuel	0.009	0.011	0.015	0.002	0.000011
		All to SRS	0.009	0.011	0.014	0.002	0.000010
	HS/ORR	Geographic	0.009	0.013	0.009	0.005	0.000039
		By Fuel	0.010	0.014	0.015	0.003	0.000016
		All to INEL	0.016	0.025	0.019	0.008	0.000023
		All to SRS	0.009	0.011	0.014	0.002	0.000014
Centralization	INEL		0.013	0.013	0.018	0.003	0.000013
	SRS		0.009	0.011	0.014	0.002	0.000010
	HS	Geographic	0.019	0.047	0.010	0.024	0.000124
		By Fuel	0.011	0.015	0.016	0.003	0.000037
		All to INEL	0.016	0.025	0.019	0.008	0.000023
		All to SRS	0.010	0.013	0.015	0.002	0.000042
	NTS	Geographic	0.018	0.041	0.010	0.024	0.000136
		By Fuel	0.012	0.016	0.016	0.004	0.000042
		All to INEL	0.017	0.027	0.020	0.010	0.000050
		All to SRS	0.010	0.012	0.015	0.002	0.000040
	ORR	Geographic	0.009	0.013	0.009	0.005	0.000043
		By Fuel	0.012	0.020	0.015	0.007	0.000038
		All to INEL	0.025	0.052	0.020	0.027	0.000120
		All to SRS	0.009	0.011	0.014	0.002	0.000014

All risks are expressed in latent cancer fatalities during the implementation of the policy, except for the Accidental-Traffic column, which is a number of fatalities.

Table E-44 Tabulation of Overland Transportation Risks: Five-Year Spent Nuclear Fuel Acceptance Only, All Shipments via Truck, Lower Bound Risk Factors

Alternative / Option			Routine			Accidental	
Programmatic SNF & INEL EIS Alternative	SNF Site Option	Phase I Approach	Radiological		Nonradiological		Radio-logical
			Crew	Public	Emis.	Traffic	
Decentralization	INEL/SRS		0.011	0.033	0.001	0.019	0.000005
1992/1993 Planning Basis	INEL/SRS		0.011	0.033	0.001	0.019	0.000005
Regionalization by Fuel Type	INEL/SRS		0.025	0.078	0.003	0.044	0.000010
Regionalization by Geography	INEL/SRS		0.011	0.033	0.001	0.019	0.000005
	INEL/ORR	Geographic	0.013	0.039	0.001	0.023	0.000038
		By Fuel	0.027	0.084	0.003	0.048	0.000043
		All to INEL	0.041	0.131	0.006	0.073	0.000018
	NTS/SRS	Geographic	0.012	0.036	0.001	0.021	0.000014
		By Fuel	0.026	0.081	0.003	0.046	0.000019
		All to SRS	0.023	0.071	0.002	0.039	0.000010
	NTS/ORR	Geographic	0.014	0.042	0.002	0.025	0.000047
		By Fuel	0.029	0.087	0.003	0.049	0.000052
		All to INEL	0.046	0.145	0.007	0.081	0.000055
		All to SRS	0.026	0.079	0.003	0.044	0.000053
	HS/SRS	Geographic	0.012	0.035	0.001	0.021	0.000008
		By Fuel	0.026	0.081	0.003	0.045	0.000013
		All to SRS	0.023	0.071	0.002	0.039	0.000010
	HS/ORR	Geographic	0.014	0.041	0.001	0.025	0.000041
		By Fuel	0.028	0.087	0.003	0.049	0.000046
		All to INEL	0.045	0.143	0.006	0.078	0.000028
		All to SRS	0.026	0.079	0.003	0.044	0.000053
Centralization	INEL		0.041	0.131	0.006	0.073	0.000018
	SRS		0.023	0.071	0.002	0.039	0.000010
	HS	Geographic	0.024	0.075	0.003	0.044	0.000125
		By Fuel	0.039	0.121	0.004	0.069	0.000131
		All to INEL	0.045	0.143	0.006	0.078	0.000028
		All to SRS	0.040	0.123	0.004	0.070	0.000164
	NTS	Geographic	0.023	0.070	0.003	0.044	0.000144
		By Fuel	0.038	0.116	0.005	0.068	0.000149
		All to INEL	0.046	0.145	0.007	0.081	0.000055
		All to SRS	0.038	0.115	0.005	0.068	0.000180
	ORR	Geographic	0.016	0.048	0.002	0.029	0.000064
		By Fuel	0.030	0.093	0.003	0.053	0.000068
		All to INEL	0.053	0.170	0.007	0.097	0.000125
		All to SRS	0.026	0.079	0.003	0.044	0.000053

All risks are expressed in latent cancer fatalities during the implementation of the policy, except for the Accidental-Traffic column, which is a number of fatalities.

Table E-45 Tabulation of Overland Transportation Risks: Five-Year Spent Nuclear Fuel Acceptance Only, All Shipments from Ports via Truck, Intersite Shipments via Rail, Lower Bound Risk Factors

Alternative / Option			Routine			Accidental	
Programmatic SNF & INEL EIS Alternative	SNF Site Option	Phase I Approach	Radiological		Nonradiological		Radio-logical
			Crew	Public	Emis.	Traffic	
Decentralization	INEL/SRS						
1992/1993 Planning Basis	INEL/SRS						
Regionalization by Fuel Type	INEL/SRS						
Regionalization by Geography	INEL/SRS						
	INEL/ORR	Geographic	0.011	0.033	0.001	0.020	0.000009
		By Fuel	0.026	0.078	0.003	0.044	0.000014
		All to INEL	0.041	0.131	0.006	0.073	0.000018
	NTS/SRS	Geographic	0.011	0.033	0.001	0.020	0.000006
		By Fuel	0.025	0.078	0.003	0.044	0.000011
		All to SRS	0.023	0.071	0.002	0.039	0.000010
	NTS/ORR	Geographic	0.011	0.033	0.001	0.020	0.000009
		By Fuel	0.026	0.078	0.003	0.044	0.000014
		All to INEL	0.042	0.132	0.006	0.073	0.000021
		All to SRS	0.024	0.071	0.002	0.039	0.000014
	HS/SRS	Geographic	0.011	0.033	0.001	0.020	0.000006
		By Fuel	0.025	0.078	0.003	0.044	0.000011
		All to SRS	0.023	0.071	0.002	0.039	0.000010
	HS/ORR	Geographic	0.011	0.033	0.001	0.020	0.000010
		By Fuel	0.026	0.078	0.003	0.044	0.000015
		All to INEL	0.042	0.132	0.006	0.073	0.000022
		All to SRS	0.024	0.071	0.002	0.039	0.000014
Centralization	INEL						
	SRS						
	HS	Geographic	0.012	0.034	0.002	0.020	0.000031
		By Fuel	0.027	0.079	0.004	0.044	0.000036
		All to INEL	0.042	0.132	0.006	0.073	0.000022
		All to SRS	0.025	0.073	0.004	0.039	0.000042
	NTS	Geographic	0.012	0.034	0.002	0.020	0.000030
		By Fuel	0.027	0.079	0.004	0.044	0.000035
		All to INEL	0.042	0.132	0.006	0.073	0.000021
		All to SRS	0.025	0.072	0.004	0.039	0.000041
	ORR	Geographic	0.012	0.033	0.001	0.020	0.000014
		By Fuel	0.026	0.079	0.003	0.044	0.000019
		All to INEL	0.042	0.132	0.007	0.074	0.000039
		All to SRS	0.024	0.071	0.002	0.039	0.000014

All risks are expressed in latent cancer fatalities during the implementation of the policy, except for the Accidental-Traffic column, which is a number of fatalities.

Table E-46 Tabulation of Overland Transportation Risks: Five-Year Spent Nuclear Fuel Acceptance Only, All Shipments via Rail, Lower Bound Risk Factors

Alternative / Option			Routine			Accidental	
			Radiological		Nonradiological		Radio-logical
Programmatic SNF & INEL EIS Alternative	SNF Site Option	Phase I Approach	Crew	Public	Emis.	Traffic	
Decentralization	INEL/SRS		0.005	0.005	0.006	0.001	0.000003
1992/1993 Planning Basis	INEL/SRS		0.005	0.005	0.006	0.001	0.000003
Regionalization by Fuel Type	INEL/SRS		0.008	0.009	0.011	0.001	0.000004
Regionalization by Geography	INEL/SRS		0.005	0.005	0.006	0.001	0.000003
	INEL/ORR	Geographic	0.006	0.006	0.007	0.001	0.000006
		By Fuel	0.008	0.009	0.011	0.002	0.000007
		All to INEL	0.011	0.009	0.012	0.002	0.000003
	NTS/SRS	Geographic	0.005	0.006	0.006	0.001	0.000004
		By Fuel	0.008	0.009	0.011	0.002	0.000004
		All to SRS	0.008	0.009	0.011	0.001	0.000004
	NTS/ORR	Geographic	0.007	0.011	0.007	0.004	0.000037
		By Fuel	0.009	0.012	0.012	0.003	0.000016
		All to INEL	0.015	0.023	0.013	0.010	0.000040
		All to SRS	0.008	0.009	0.011	0.001	0.000008
	HS/SRS	Geographic	0.005	0.006	0.006	0.001	0.000004
		By Fuel	0.008	0.009	0.011	0.002	0.000005
		All to SRS	0.008	0.009	0.011	0.001	0.000004
	HS/ORR	Geographic	0.007	0.011	0.007	0.004	0.000037
		By Fuel	0.009	0.012	0.011	0.003	0.000009
		All to INEL	0.014	0.020	0.012	0.008	0.000013
		All to SRS	0.008	0.009	0.011	0.001	0.000008
Centralization	INEL		0.011	0.009	0.012	0.002	0.000003
	SRS		0.008	0.009	0.011	0.001	0.000004
	HS	Geographic	0.018	0.045	0.008	0.024	0.000122
		By Fuel	0.010	0.013	0.012	0.003	0.000031
		All to INEL	0.014	0.020	0.012	0.008	0.000013
		All to SRS	0.009	0.011	0.012	0.002	0.000036
	NTS	Geographic	0.017	0.040	0.008	0.023	0.000133
		By Fuel	0.010	0.013	0.013	0.004	0.000036
		All to INEL	0.015	0.023	0.013	0.010	0.000040
		All to SRS	0.009	0.010	0.013	0.002	0.000035
	ORR	Geographic	0.008	0.011	0.007	0.004	0.000041
		By Fuel	0.011	0.018	0.012	0.007	0.000032
		All to INEL	0.023	0.048	0.013	0.026	0.000110
		All to SRS	0.008	0.009	0.011	0.001	0.000008

All risks are expressed in latent cancer fatalities during the implementation of the policy, except for the Accidental-Traffic column, which is a number of fatalities.

Table E-47 Tabulation of Overland Transportation Risks: Five-Year Spent Nuclear Fuel Acceptance Only, All Shipments via Truck, Upper Bound Risk Factors

Alternative / Option			Routine				Accidental
Programmatic SNF & INEL EIS Alternative	SNF Site Option	Phase I Approach	Radiological Crew	Radiological Public	Nonradiological Emis.	Nonradiological Traffic	Radiological
Decentralization	INEL/SRS		0.027	0.078	0.005	0.046	0.00006
1992/1993 Planning Basis	INEL/SRS		0.027	0.078	0.005	0.046	0.00006
Regionalization by Fuel Type	INEL/SRS		0.039	0.118	0.008	0.073	0.00009
Regionalization by Geography	INEL/SRS		0.027	0.078	0.005	0.046	0.00006
	INEL/ORR	Geographic	0.029	0.083	0.006	0.050	0.00009
		By Fuel	0.041	0.124	0.009	0.077	0.00012
		All to INEL	0.052	0.165	0.010	0.101	0.00011
	NTS/SRS	Geographic	0.028	0.081	0.006	0.048	0.00006
		By Fuel	0.040	0.121	0.009	0.075	0.00010
		All to SRS	0.038	0.113	0.008	0.068	0.00009
	NTS/ORR	Geographic	0.030	0.087	0.006	0.052	0.00010
		By Fuel	0.042	0.127	0.009	0.078	0.00013
		All to INEL	0.057	0.179	0.011	0.109	0.00015
		All to SRS	0.041	0.120	0.009	0.073	0.00013
	HS/SRS	Geographic	0.027	0.080	0.005	0.047	0.00006
		By Fuel	0.040	0.121	0.008	0.074	0.00009
		All to SRS	0.038	0.113	0.008	0.068	0.00009
	HS/ORR	Geographic	0.030	0.086	0.006	0.051	0.00009
		By Fuel	0.042	0.126	0.009	0.078	0.00013
		All to INEL	0.056	0.176	0.010	0.107	0.00012
		All to SRS	0.041	0.120	0.009	0.073	0.00013
Centralization	INEL		0.052	0.165	0.010	0.101	0.00011
	SRS		0.038	0.113	0.008	0.068	0.00009
	HS	Geographic	0.040	0.120	0.007	0.071	0.00018
		By Fuel	0.053	0.161	0.010	0.098	0.00021
		All to INEL	0.056	0.176	0.010	0.107	0.00012
		All to SRS	0.054	0.165	0.011	0.099	0.00024
	NTS	Geographic	0.039	0.115	0.007	0.071	0.00019
		By Fuel	0.052	0.156	0.010	0.097	0.00023
		All to INEL	0.057	0.179	0.011	0.109	0.00015
		All to SRS	0.053	0.157	0.011	0.098	0.00026
	ORR	Geographic	0.032	0.093	0.006	0.056	0.00011
		By Fuel	0.044	0.133	0.009	0.082	0.00015
		All to INEL	0.064	0.203	0.011	0.125	0.00022
		All to SRS	0.041	0.120	0.009	0.073	0.00013

All risks are expressed in latent cancer fatalities during the implementation of the policy, except for the Accidental-Traffic column, which is a number of fatalities.

Table E-48 Tabulation of Overland Transportation Risks: Five-Year Spent Nuclear Fuel Acceptance Only, All Shipments from Ports via Truck, Intersite Shipments via Rail, Upper Bound Risk Factors

Alternative / Option			Routine			Accidental	
Programmatic SNF & INEL EIS Alternative	SNF Site Option	Phase I Approach	Radiological		Nonradiological		Radio-logical
			Crew	Public	Emis.	Traffic	
Decentralization	INEL/SRS						
1992/1993 Planning Basis	INEL/SRS						
Regionalization by Fuel Type	INEL/SRS						
Regionalization by Geography	INEL/SRS						
	INEL/ORR	Geographic	0.027	0.078	0.005	0.046	0.00006
		By Fuel	0.040	0.118	0.008	0.073	0.00009
		All to INEL	0.052	0.165	0.010	0.101	0.00011
	NTS/SRS	Geographic	0.027	0.078	0.005	0.046	0.00006
		By Fuel	0.039	0.118	0.008	0.073	0.00009
		All to SRS	0.038	0.113	0.008	0.068	0.00009
	NTS/ORR	Geographic	0.027	0.078	0.005	0.046	0.00006
		By Fuel	0.040	0.118	0.008	0.073	0.00009
		All to INEL	0.053	0.165	0.010	0.102	0.00012
		All to SRS	0.038	0.113	0.009	0.069	0.00009
	HS/SRS	Geographic	0.027	0.078	0.005	0.046	0.00006
		By Fuel	0.039	0.118	0.008	0.073	0.00009
		All to SRS	0.038	0.113	0.008	0.068	0.00009
	HS/ORR	Geographic	0.027	0.078	0.005	0.046	0.00006
		By Fuel	0.040	0.118	0.008	0.073	0.00009
		All to INEL	0.053	0.165	0.010	0.102	0.00012
		All to SRS	0.038	0.113	0.009	0.069	0.00009
Centralization	INEL						
	SRS						
	HS	Geographic	0.028	0.079	0.006	0.047	0.00008
		By Fuel	0.041	0.119	0.009	0.073	0.00012
		All to INEL	0.053	0.165	0.010	0.102	0.00012
		All to SRS	0.040	0.114	0.010	0.069	0.00012
	NTS	Geographic	0.028	0.079	0.006	0.047	0.00008
		By Fuel	0.041	0.119	0.009	0.073	0.00011
		All to INEL	0.053	0.165	0.010	0.102	0.00012
		All to SRS	0.040	0.114	0.010	0.069	0.00012
	ORR	Geographic	0.027	0.078	0.006	0.046	0.00006
		By Fuel	0.040	0.118	0.009	0.073	0.00010
		All to INEL	0.054	0.165	0.011	0.102	0.00014
		All to SRS	0.038	0.113	0.009	0.069	0.00009

All risks are expressed in latent cancer fatalities during the implementation of the policy, except for the Accidental-Traffic column, which is a number of fatalities.

Table E-49 Tabulation of Overland Transportation Risks: Five-Year Spent Nuclear Fuel Acceptance Only, All Shipments via Rail, Upper Bound Risk Factors

Alternative / Option			Routine			Accidental	
			Radiological		Nonradiological		Radio-
Programmatic SNF & INEL EIS Alternative	SNF Site Option	Phase I Approach	Crew	Public	Emis.	Traffic	logical
Decentralization	INEL/SRS		0.008	0.012	0.016	0.002	0.00002
1992/1993 Planning Basis	INEL/SRS		0.008	0.012	0.016	0.002	0.00002
Regionalization by Fuel Type	INEL/SRS		0.011	0.016	0.026	0.002	0.00003
Regionalization by Geography	INEL/SRS		0.008	0.012	0.016	0.002	0.00002
	INEL/ORR	Geographic	0.009	0.013	0.016	0.002	0.00002
		By Fuel	0.011	0.016	0.026	0.002	0.00004
		All to INEL	0.013	0.016	0.039	0.003	0.00004
	NTS/SRS	Geographic	0.009	0.012	0.016	0.002	0.00002
		By Fuel	0.011	0.016	0.026	0.002	0.00003
		All to SRS	0.011	0.017	0.022	0.002	0.00003
	NTS/ORR	Geographic	0.011	0.018	0.016	0.005	0.00005
		By Fuel	0.012	0.020	0.026	0.004	0.00004
		All to INEL	0.018	0.030	0.041	0.011	0.00008
		All to SRS	0.011	0.017	0.022	0.002	0.00004
	HS/SRS	Geographic	0.008	0.012	0.016	0.002	0.00002
		By Fuel	0.011	0.016	0.026	0.002	0.00003
		All to SRS	0.011	0.017	0.022	0.002	0.00003
	HS/ORR	Geographic	0.011	0.018	0.016	0.005	0.00005
		By Fuel	0.012	0.019	0.026	0.004	0.00004
		All to INEL	0.017	0.027	0.040	0.008	0.00005
		All to SRS	0.011	0.017	0.022	0.002	0.00004
Centralization	INEL		0.013	0.016	0.039	0.003	0.00004
	SRS		0.011	0.017	0.022	0.002	0.00003
	HS	Geographic	0.021	0.052	0.017	0.025	0.00014
		By Fuel	0.013	0.020	0.027	0.004	0.00006
		All to INEL	0.017	0.027	0.040	0.008	0.00005
		All to SRS	0.012	0.018	0.023	0.003	0.00006
	NTS	Geographic	0.020	0.046	0.017	0.024	0.00015
		By Fuel	0.013	0.020	0.027	0.004	0.00007
		All to INEL	0.018	0.030	0.041	0.011	0.00008
		All to SRS	0.012	0.018	0.023	0.003	0.00006
	ORR	Geographic	0.011	0.018	0.016	0.005	0.00006
		By Fuel	0.014	0.025	0.026	0.008	0.00006
		All to INEL	0.025	0.055	0.041	0.027	0.00015
		All to SRS	0.011	0.017	0.022	0.002	0.00004

All risks are expressed in latent cancer fatalities during the implementation of the policy, except for the Accidental-Traffic column, which is a number of fatalities.

E.8.7 Implementation Alternative - Implementing an Acceptance Policy by Taking Title at Varying Locations

The agency that has title to the spent nuclear fuel has no significant effect on overland transportation. The effects calculated for the basic implementation apply here.

E.8.8 Implementation Alternative - Implementing an Acceptance Policy and Storing Underwater

The use of underwater storage would have only minor effects on the location to which foreign research reactor spent nuclear fuel were delivered on the DOE sites. However, since there is some degree of uncertainty in the exact delivery location on all the DOE sites and intrasite transportation would be less likely, the effects calculated for the basic implementation apply here.

E.8.9 Implementation Alternative - Implementing an Acceptance Policy and Near-Term Chemical Separation in the United States

The performance of conventional or alternative chemical separation is only considered feasible at the Idaho National Engineering Laboratory and Savannah River Site sites. The requirements for overland transportation are not affected by the activities at the sites. Therefore, the impacts calculated in Section E.7 for the options to transport fuel to Idaho National Engineering Laboratory and/or Savannah River Site under the Regionalization by Fuel Type or Centralization alternatives would apply to this section. They are shown in Table E-50.

Table E-50 Tabulation of Overland Transportation Risks: Chemical Separation in the United States

Alternative/Option			*Incident-free*				*Accidental*
			Radiological		*Nonradiological*		
Implementation	*Mode*	*Risk Factors*	*Crew*	*Public*	*Emis.*	*Traffic*	*Radiological*
Regionalization by Fuel Type	Truck	Upper	0.048	0.143	0.010	0.088	0.000109
		Nominal	0.036	0.112	0.005	0.067	0.000039
		Lower	0.030	0.093	0.003	0.052	0.000012
	Rail	Upper	0.013	0.020	0.031	0.003	0.000040
		Nominal	0.011	0.014	0.018	0.002	0.000012
		Lower	0.010	0.011	0.014	0.002	0.000005
Centralization to Idaho National Engineering Laboratory	Truck	Upper	0.065	0.205	0.012	0.126	0.000143
		Nominal	0.062	0.195	0.009	0.112	0.000069
		Lower	0.051	0.163	0.007	0.091	0.000023
	Rail	Upper	0.016	0.020	0.049	0.004	0.000053
		Nominal	0.016	0.016	0.023	0.004	0.000016
		Lower	0.013	0.011	0.015	0.003	0.000004
Centralization to Savannah River Site	Truck	Upper	0.046	0.137	0.010	0.083	0.000107
		Nominal	0.033	0.097	0.005	0.062	0.000035
		Lower	0.028	0.085	0.003	0.047	0.000012
	Rail	Upper	0.013	0.020	0.027	0.003	0.000038
		Nominal	0.011	0.013	0.017	0.002	0.000012
		Lower	0.009	0.011	0.013	0.002	0.000005

All risks are expressed in latent cancer fatalities during the foreign research reactor spent nuclear fuel policy, except for the Accidental - Traffic column, which is the number of fatalities during the policy.

Impacts of Incident-Free Ground Transport

The incident-free transportation of spent nuclear fuel was estimated to result in total latent fatalities that ranged from 0.020 to 0.27 over the entire duration of the program. These fatalities are the sum of the estimated number of radiation-related LCFs to the public and the crew.

The range of fatality estimates is caused by two factors: 1) the option of using truck or rail to transport spent nuclear fuel, and, 2) the difference between the risk factors for the port-to-site routes.

The estimated number of radiation-related LCFs for transportation workers ranged from 0.009 to 0.065. The estimated number of radiation-related LCFs for the general population ranged from 0.011 to 0.21, and the estimated number of nonradiological fatalities from vehicular emissions ranged from 0.003 to 0.05.

Impacts of Accidents During Ground Transport

The cumulative transportation accident risks over the entire program are estimated to range from 0.000004 to 0.00014 LCFs from radiation and from 0.002 to 0.13 for traffic fatality, depending on the transportation mode and DOE sites selected. Both indicate an expectation of less than one fatality.

The impacts of overland transportation are shown in Table E-50. The analysis for this implementation alternative is analogous to the analysis performed for the basic implementation of Management Alternative 1 (see Section E.7.2), and the interpretation of the tables is the same as described in Section E.7.2.

The consequences of the most severe accident hypothesized are the same as described for the Basic Implementation since the material at risk is the same.

E.8.10 Developmental Processing Capabilities

The overland transportation impacts would be based on the site selected for processing, and would be determined after that site is selected.

E.8.11 Management Alternative - Adopt a Strategy of Managing Foreign Research Reactor Spent Nuclear Fuel Overseas: Store Overseas

There would be no overland transportation impacts in the United States if this alternative were implemented.

E.8.12 Policy Alternative - Adopt a Strategy of Managing Foreign Research Reactor Spent Nuclear Fuel Overseas: Process Overseas and Ship Vitrified High-Level Waste to the United States

The total amount of foreign research reactor spent nuclear fuel could be reduced into 16 vitrified waste logs, which could be carried in 8 casks. The contents of each cask is described isotopically in Table E-3. The curie content is based on the total number of curies expected to be returned to the United States under the basic implementation of Management Alternative 1. Realistically, the logs might have to be allowed to decay at the vitrification facility until the dose rate was below the regulatory-limit. Therefore, all incident-free calculations assume the dose rate is 10 mrem per hr at 2 m (6.6 ft).

This alternative is assumed to be independent of the SNF&INEL Final EIS (DOE, 1995) results. The only site considered for interim storage of vitrified high-level waste is the Savannah River Site. The only overseas facilities are in Europe, so all shipments are assumed to arrive on the east coast.

Impacts of Incident-Free Ground Transport

The incident-free transportation of spent nuclear fuel was estimated to result in total latent fatalities that ranged from 0.0002 to 0.004 over the entire duration of the program. These results are the sum of the estimated number of radiation-related LCFs to the public and the crews.

The range of fatality estimates is caused by the difference between the risk factors for the port-to-site routes.

The estimated number of radiation-related LCFs for transportation workers ranged from 0.00014 to 0.001. The estimated number of radiation-related LCFs for the general population ranged from 0.00009 to 0.003, and the estimated number of nonradiological fatalities from vehicular emissions ranged from 0.0001 to 0.0005.

Impacts of Accidents During Ground Transport

The cumulative transportation accident risks over the entire program are estimated to range from 1.9×10^{-7} to 5.9×10^{-6} LCF from radiation and from 0.00003 to 0.002 for traffic fatality, depending on the transportation mode and DOE sites selected. Both indicate an expectation of less than one fatality.

The impacts of overland transportation are shown in Tables E-51 and E-52.

Table E-51 Tabulation of Ground Transportation Risks: Vitrified High-Level Waste Acceptance Only

Alternative/Option			*Incident-free*				*Accidental*
			Radiological		*Nonradiological*		
Implementation	*Mode*	*Risk Factors*	*Crew*	*Public*	*Emis.*	*Traffic*	*Radiological*
Ship directly to repository	Truck	Upper	0.00076	0.00240	0.00016	0.00162	5.9×10^{-6}
		Nominal	0.00072	0.00227	0.00013	0.00143	5.0×10^{-6}
		Lower	0.00053	0.00172	0.00010	0.00106	1.7×10^{-6}
	Rail	Upper	0.00020	0.00024	0.00052	0.00005	2.0×10^{-6}
		Nominal	0.00019	0.00019	0.00025	0.00005	1.2×10^{-6}
		Lower	0.00014	0.00009	0.00015	0.00003	1.9×10^{-7}
Ship to Savannah River Site, then to repository	Truck	Upper	0.00102	0.00302	0.00018	0.00196	1.0×10^{-5}
		Nominal	0.00083	0.00249	0.00013	0.00168	7.6×10^{-6}
		Lower	0.00076	0.00227	0.00011	0.00153	6.3×10^{-6}
	Rail	Upper	0.00029	0.00030	0.00035	0.00007	2.3×10^{-6}
		Nominal	0.00025	0.00021	0.00022	0.00006	1.3×10^{-6}
		Lower	0.00023	0.00018	0.00019	0.00005	9.7×10^{-7}

All risks are expressed in latent cancer fatalities during the foreign research reactor spent nuclear fuel policy, except for the Accidental - Traffic column, which is the number of fatalities during the policy.

E.8.13 Management Alternative - The Hybrid Alternative

The hybrid alternative is based on the SNF&INEL Final EIS (DOE, 1995) Regionalization by Fuel Type. The origin of shipment count is described in detail in Chapter 2 and Appendix B. The shipment count is:

	East Coast		*West Coast*		*Totals*
	Aluminum	*TRIGA*	*Aluminum*	*TRIGA*	
Phase 1	212	82	101	42	437
Phase 2	63	25	30	13	131
Total	**275**	**107**	**131**	**55**	**568**

Table E-52 Potential Consequences for the Most Severe Accidents Involving Shipments of Foreign Research Reactor High-Level Waste[a,b]

	Neutral Conditions[c]				Stable Conditions[d]			
	Population[e]		MEI[f]		Population[e]		MEI[f]	
Mode and Accident Location	Dose (person-rem)	Consequences (LCF)	Dose (rem)	Consequences (LCF)	Dose (person-rem)	Consequences (LCF)	Dose (rem)	Consequences (LCF)
Truck								
Urban	121	0.06	0.09	0.000044	970	0.48	0.29	0.00015
Suburban	22.5	0.01	0.09	0.000044	180	0.09	0.29	0.00015
Rural	0.4	0.0002	0.09	0.000044	3.2	0.002	0.29	0.00015
Rail								
Urban	121	0.06	0.09	0.000044	907	0.48	0.29	0.00015
Suburban	22.5	0.01	0.09	0.000044	180	0.09	0.29	0.00015
Rural	0.4	0.0002	0.09	0.000044	3.2	0.002	0.29	0.00015

[a] *The most severe accidents correspond to the highest NUREG-0170 accident severity category (category VIII) (NRC, 1977a). It was assumed that 0.000001 of the radioactive material would be released from its packaging and 5 percent of the aerosolized release would be respirable following an accident.*

[b] *Buoyant plume rise resulting from fire for a severe accident was included in the exposure model.*

[c] *Neutral weather conditions result in moderate dispersion and dilution of the release plume. Neutral conditions were taken to be Pasquill stability Class D with a wind speed of 4 m per sec (9 mph). Neutral conditions occur approximately 50 percent of the time in the United States.*

[d] *Stable weather conditions result in minimal dispersion and dilution of the release plume and are thus unfavorable. Stable conditions were taken to be Pasquill stability Class F with a wind speed of 1 m per sec (2.2 mph). Stable conditions occur approximately one-third of the time in the United States.*

[e] *Populations extend at a uniform density to a radius of 80 km (50 mi) from the accident site. Population exposure pathways include acute inhalation; acute cloudshine; groundshine; resuspended inhalation; resuspended cloudshine; and ingestion of food, including initially contaminated food (rural only). No decontamination or mitigative actions are taken.*

[f] *The MEI is assumed to be at the location of maximum exposure. The locations of maximum exposure would be 160 m (528 ft) and 400 m (1,320 ft) from the accident site under neutral and stable atmospheric conditions, respectively. Individual exposure pathways include acute inhalation, acute cloudshine, and groundshine during passage of the plume. No ingested dose is considered.*

No intersite shipment is necessary for this alternative. The risk estimates are summarized in Table E-53.

Impacts of Incident-Free Ground Transport

The incident-free transportation of spent nuclear fuel was estimated to result in total latent fatalities that ranged from 0.009 to 0.15 over the entire duration of the program. These fatalities are the sum of the estimated number of radiation-related LCFs to the public and the crew.

The range of fatality estimates is caused by two factors: 1) the option of using truck or rail to transport spent nuclear fuel, and, 2) the difference between the risk factors for the port-to-site routes.

The estimated number of radiation-related LCFs for transportation workers ranged from 0.008 to 0.037. The estimated number of radiation-related LCFs for the general population ranged from 0.01 to 0.11, and the estimated number of nonradiological fatalities from vehicular emissions ranged from 0.003 to 0.025.

Table E-53 Tabulation of Overland Transportation Risks: Management Alternative 3 (Hybrid Alternative)

Alternative/Option			*Incident-free*				*Accidental*
			Radiological		*Nonradiological*		
Implementation	*Mode*	*Risk Factors*	*Crew*	*Public*	*Emis.*	*Traffic*	*Radiological*
Regionalization by Fuel Type	Truck	Upper	0.037	0.112	0.008	0.069	0.000081
		Nominal	0.033	0.098	0.005	0.058	0.000035
		Lower	0.028	0.087	0.003	0.048	0.000012
	Rail	Upper	0.010	0.015	0.025	0.002	0.000030
		Nominal	0.009	0.012	0.016	0.002	0.000011
		Lower	0.008	0.010	0.013	0.002	0.000005

All risks are expressed in latent cancer fatalities during the foreign research reactor spent nuclear fuel except for the Accidental - Traffic column, which is the number of fatalities during the policy

Impacts of Accidents During Ground Transport

The cumulative transportation accident risks over the entire program are estimated to range from 4.5×10^{-6} to 0.000081 LCFs from radiation and from 0.0017 to 0.069 for traffic fatality, depending on the transportation mode and DOE sites selected. Both indicate an expectation of less than one fatality.

The impacts of overland transportation are shown in Table E-53. The analysis for this implementation alternative is analogous to the analysis performed for the basic implementation of Management Alternative 1 (see Section E.7.2), and the interpretation of the tables is the same as described in Section E.7.2.

E.8.14 Transportation Implementation Example - Ship All Foreign Research Reactor Spent Nuclear Fuel to a Single Port, Regionalization-By-Fuel-Type

All the implementation alternatives analyzed in Section E.8 have been analyzed under the assumption that all foreign research reactor spent nuclear fuel would be delivered to ports on the coast nearest to the foreign research reactor (Section E.3.3). This assumption is a reasonable approximation and simplification to a complex set of possible implementation approaches. The following section, however, presents the results of the analysis associated with overland transportation risk of transporting the foreign research reactor spent nuclear fuel from a single commercial or military port.

DOE could bring all spent nuclear fuel through any identified military or commercial port. This would result in 721 shipments to that single port over the 13-year duration of the policy. Canadian fuel would be shipped overland as previously analyzed. The impacts can be directly compared with the impacts of the basic implementation of Management Alternative 1 previously analyzed under the assumption that the foreign research reactor spent nuclear fuel would arrive at the coast nearest the foreign research reactor.

Impacts of Incident-Free Ground Transportation

The incident-free transportation of spent nuclear fuel was estimated to result in total latent fatalities that ranged from 0.017 to 0.272 over the entire duration of the program. These fatalities are the sums of the estimated number of radiation-related LCFs to the public and the crew.

The range of fatality estimates are caused by two factors: 1) the option of using truck or rail to transport spent nuclear fuel, and 2) the difference between the risk factors for the port-to-site routes.

The estimated number of radiation-related LCFs for transportation workers ranged from 0.008 to 0.069. The estimated number of radiation-related LCFs for the general population ranged from 0.009 to 0.213, and the estimated number of nonradiological fatalities from vehicular emissions ranged from 0.002 to 0.035.

Impacts of Accidents During Ground Transportation

The cumulative transportation accident risks over the entire program are estimated to range from 0.00001 to 0.00015 LCFs from radiation and from 0.001 to 0.127 for traffic fatality, depending on the transportation mode and management site(s) selected. The reasons for the range of fatality estimates are the same as those described for incident-free transportation. Both show an expectation of less than one fatality.

The consequences of the most severe accident hypothesized are the same as described for the basic implementation of Management Alternative 1 since the material at risk is the same.

Conclusion

The overland transportation risk associated with bringing all foreign research reactor spent nuclear fuel to a single port is generally within the bounds of the previous analysis that assumed that spent nuclear fuel would arrive at the coast nearest to the foreign source. In the specific case of Regionalization-By-Fuel-Type, the overland transportation risks are reduced by shipping the aluminum-based spent nuclear fuel to an east coast port. The estimated impacts of overland transportation are driven by DOE's selection of a port and the transportation mode. The increased cost and risk associated with shipping the spent nuclear fuel from Asia and Australia to the U.S. east coast are analyzed in Appendices C and F. Table E-54 gives the risk estimates associated with implementing the entire policy from each of the selected ports. The risk estimates are tabulated in a form that can be compared with the other policy and implementation alternatives analyzed in this appendix.

E.8.15 Transportation Implementation Example - Transportation by Barge

As an alternative to truck or rail transport of foreign research reactor spent nuclear fuel, barge transport from Savannah, GA to the Savannah River Site and from Portland, OR to the Hanford Site was evaluated. This section summarizes the impacts.

The analysis of the impacts of barge transportation closely parallels the analysis of truck and rail transportation described in preceding sections. Routing data was generated using the INTERLINE code for the barge routes and the HIGHWAY code for the short trucking segment. A conservative dose rate of 10 mrem per hr at 2 m (6.6 feet) from the vehicle, which is the regulatory limit, was used for calculational purposes. The RADTRAN 4 code was used to calculate the incident-free doses to the public and barge crew. The analysis of port worker consequences on breakbulk vessels was used to estimate the dose to handlers.

The barge analysis used the same radionuclide inventories used in previous sections. The RADTRAN 4 code was used to calculate the impacts of hypothetical accidental releases to the air. A specific waterborne analysis, was performed for barge accidents. Two very conservative assumptions were used in estimating the quantity of material released following an accident:

- Release fractions that determine the source term for dispersion into the water are the same as those used for similar airborne release scenarios, and

Table E-54 Tabulation of Overland Transportation Risks: Basic Implementation, All Shipments to Any Single Port, Regionalization by Fuel Type

Port	Mode	Routine				Accidental
		Radiological		Non-Radiological		
		Crew	Public	Emission	Traffic	Radiological
Charleston, SC (NWS)	Truck	0.023	0.070	0.002	0.047	0.00004
	Rail	0.008	0.009	0.011	0.001	0.00001
Charleston, SC (Wando Terminal)	Truck	0.024	0.071	0.003	0.048	0.00005
	Rail	0.008	0.009	0.011	0.001	0.00001
Galveston, TX	Truck	0.039	0.114	0.007	0.070	0.00008
	Rail	0.011	0.016	0.031	0.002	0.00003
Newport News, VA	Truck	0.031	0.093	0.005	0.060	0.00006
	Rail	0.010	0.012	0.015	0.002	0.00002
Norfolk, VA	Truck	0.031	0.091	0.003	0.060	0.00006
	Rail	0.010	0.012	0.014	0.002	0.00002
Portsmouth, VA	Truck	0.031	0.092	0.004	0.060	0.00006
	Rail	0.010	0.011	0.013	0.002	0.00002
Jacksonville, FL	Truck	0.027	0.082	0.002	0.053	0.00005
	Rail	0.009	0.009	0.011	0.001	0.00001
MOTSU, NC	Truck	0.023	0.073	0.002	0.047	0.00004
	Rail	0.009	0.010	0.011	0.002	0.00001
NWS-Concord, CA	Truck	0.069	0.213	0.019	0.127	0.00012
	Rail	0.018	0.026	0.035	0.004	0.00004
Portland, OR	Truck	0.066	0.209	0.010	0.120	0.00015
	Rail	0.018	0.021	0.027	0.004	0.00005
Savannah, GA	Truck	0.024	0.073	0.002	0.047	0.00005
	Rail	0.008	0.009	0.010	0.001	0.00001
Tacoma, WA	Truck	0.067	0.212	0.008	0.104	0.00015
	Rail	0.018	0.024	0.031	0.004	0.00005
Wilmington, NC	Truck	0.026	0.079	0.002	0.055	0.00005
	Rail	0.009	0.010	0.011	0.002	0.00001

- All of the source term resulting from an accident event is dispersed into the waterway, uniformly, over a one month period (i.e., it takes one month to recover the cask).

Barge accident statistics (Hutchinson, 1986) were used to estimate the probabilities of the accident severity classes defined in the Modal Study (Fischer et al., 1987). Barge transportation fatality statistics from Saricks and Kvitek, 1994 were used to estimate accident fatality rates. The following exposure pathways were assessed using the methodology developed by the NRC in Regulatory Guide 1.109 (NRC, 1977b):

- drinking water
- ingestion of fish
- ingestion of irrigated foods
- ingestion of meat and milk from exposed cattle
- shoreline deposits (external exposure)
- swimming (external exposure).

Collective doses were calculated for average densities for rural, suburban and urban populations, using route-specific river parameters. Additionally, MEI doses were calculated for each accident scenario in a manner analogous to that in preceding sections.

Unlike previous sections, where impacts were reported in terms of implementation of the foreign research reactor spent nuclear fuel policy, impacts are reported on a per shipment basis. As shown in Figures E-1 through E-12, the policy can be carried out in many ways, depending on the outcome of the SNF&INEL EIS (DOE, 1995) and its Record of Decision. The SNF&INEL EIS alternative that could be implemented using only barge transportation is Centralization to the Savannah River Site or the Hanford Site. All others would require various mixtures of barge transportation and overland transportation via truck or rail. Therefore, barge transportation impacts are reported on a per shipment basis and compared on that basis to shipments via truck or rail for the same origin/destination pair.

The results of the barge transportation analysis, along with comparable results from the analysis of truck and rail transportation are summarized in Table E-55.

Table E-55 Tabulation of Inland Transportation Risk Factors: Basic Implementation, Shipments via Barge to Hanford and Savannah River Sites

Alternative/ Option		Incident Free					Accidental	
		Radiological			Nonradiological		Radiological	
Port - Site	Mode	Crew	Handlers	Public	Emission[a]	Traffic	Air-borne	Water-borne
Savannah, GA to Savannah River Site	Truck	$8.96x10^{-6}$	N/A	0.0000277	$3.22x10^{-8}$	0.000021	$9.35x10^{-9}$	N/A
	Rail	$5.44x10^{-6}$	N/A	$2.64x10^{-6}$	$5.86x10^{-7}$	$2.38x10^{-7}$	$1.11x10^{-9}$	N/A
	Barge	$7.64x10^{-8}$	$9.60x10^{-7}$	$1.94x10^{-6}$	$2.39x10^{-7}$	$3.42x10^{-6}$	$5.90x10^{-10}$	$2.93x10^{-8}$
Portland, OR to Hanford Site	Truck	$9.40x10^{-6}$	N/A	0.0000294	$2.67x10^{-6}$	0.0000104	$1.49x10^{-8}$	N/A
	Rail	$6.28x10^{-6}$	N/A	$5.75x10^{-6}$	$4.48x10^{-6}$	$5.00x10^{-7}$	$3.75x10^{-9}$	N/A
	Barge[b]	$6.40x10^{-7}$	$1.92x10^{-6}$	$4.26x10^{-6}$	$2.44x10^{-6}$	$6.69x10^{-6}$	$1.65x10^{-8}$	$1.87x10^{-8}$

All risks are expressed in latent cancer fatalities during the implementation of the policy, except for the Accidental-Traffic column, which is a number of fatalities.

[a] *Assumes the same emission rate as rail transportation, and two-way travel.*

[b] *Includes truck shipment from Richland, WA to Hanford Site*

E.8.15.1 Evaluation of Barge Transportation from Portland, OR to the Hanford Site

Transportation Routes

Barge transportation from the port of Portland, OR, up the Columbia River to the town of Richland, WA, followed by truck shipment to the Hanford Site was analyzed. It was assumed that the port facilities at Portland could be used to load the casks to a barge without having to transport it into areas accessed by the public. The barge could have sailed up the river to either Richland, Pasco or Kennewick, WA. The difference in the risk parameters would be less than 5 percent. Richland was chosen for analysis because it is the largest of the three cities.

Incident-Free Transportation

The incident-free transportation of spent nuclear fuel was estimated to result in $1.17x10^{-5}$ total latent fatalities per shipment. These fatalities are the sum of the estimated number of radiation-related and emission-related latent fatalities for the crew, handlers, and public.

The estimated number of radiation-related LCFs for the barge and truck crews is $6.40x10^{-7}$. The number of radiation-related LCFs for handlers during handling activities (other than the initial off-load from the seagoing ship and the on-site handling) is $1.92x10^{-6}$ per shipment. The number of radiation-related LCFs for the general population is $4.26x10^{-6}$ per shipment. The number of nonradiological fatalities from vehicle emissions is $4.88x10^{-6}$ per shipment.

The MEI risk would be the same as that in the basic implementation of Management Alternative 1, which is 0.00052 LCF for the duration of the program. This estimate is based on the conservative assumption that one individual is involved in enough driving, handling and/or inspection to reach the regulatory limit of 100 mrem per year every year for the 13-year duration of the program.

Transportation Accidents

The barge transportation accident risks from radiation exposure are estimated to be $3.63x10^{-8}$ LCF per shipment. These fatalities are the sum of the estimated number of radiation-related fatalities from atmospheric and waterborne releases. The estimated number of radiation-related LCFs from atmospheric releases is $1.65x10^{-8}$ per shipment, and $1.87x10^{-8}$ per shipment for waterborne releases. The barge transportation accident risks from other accidents than radiation are estimated to be $6.6x10^{-6}$ fatalities per shipment.

The consequences of the maximum foreseeable offsite transportation accident are 0.0295 LCF. The likelihood of this accident is approximately $1x10^{-7}$.

E.8.15.2 Evaluation of Barge Transportation from Savannah, GA to the Savannah River Site

Transportation Routes

Barge transportation from the port of Savannah, GA, up the Savannah River to the Savannah River Site was analyzed. The Savannah River Site has a barge receiving facility that could be used to off-load the casks. Handling at that facility and the onsite movement to the Receiving Basin for Offsite Fuels would not result in a significant change in calculated onsite risks (Appendix D).

Incident-Free Transportation

The incident-free transportation of spent nuclear fuel was estimated to result in $3.45x10^{-6}$ total latent fatalities per shipment. These fatalities are the sum of the estimated number of radiation-related and emission-related latent fatalities for the crew, handlers, and public.

The estimated number of radiation-related LCFs for the barge and truck crews is $7.64x10^{-8}$. The number of radiation-related LCFs for handlers during handling activities (other than the initial off-load from the seagoing ship and the on-site handling) is $9.60x10^{-7}$ per shipment. The number of radiation-related LCFs for the general population is $1.94x10^{-6}$ per shipment. The number of nonradiological fatalities from vehicle emissions is $4.97x10^{-7}$ per shipment.

The MEI risk would be the same as that in the basic implementation of Management Alternative 1, which is 0.00052 LCF for the duration of the program. This estimate is based on the conservative assumption that one individual is involved in enough driving, handling and/or inspection to reach the regulatory limit of 100 mrem per year every year for the 13-year duration of the program.

Transportation Accidents

The barge transportation accident risks are estimated to be 2.12×10^{-8} LCF per shipment. These fatalities are the sum of the estimated number of radiation-related fatalities from atmospheric and waterborne releases. The estimated number of radiation-related LCFs from atmospheric releases is 5.90×10^{-10} per shipment, and 2.93×10^{-8} per shipment for waterborne releases. The barge transportation accident risks from other than radiation are estimated to be 3.42×10^{-6} fatalities per shipment.

The consequences of the maximum foreseeable offsite transportation accident are 0.0259 LCF. The likelihood of this accident is approximately 1×10^{-7}.

E.8.15.3 Conclusions on Barge Transportation

Table E-55 provides a comparison of barge shipment parameters to truck and rail shipment parameters between the same two points. For incident-free transportation, the risk to the public and onboard crew is lower than for truck or rail shipment. However, the risk increase associated with additional handling of casks negates this risk reduction. The net incident-free risk for barge transportation is essentially identical to that for rail transportation. The radiological accident risk associated with barge transportation is larger than that of truck or rail because of the consequences of a hypothetical accident in which a damaged cask is dropped into a river. As evident from Table E-55, fatality rates for barge transportation accidents are higher than traffic fatality rates for rail shipment and lower than those for highway shipment. In total, the difference between the risks of shipping by truck, rail or barge is very low.

When traveling along a river, a barge can be observed from a long distance, and due to its slow speed, can be boarded while underway. Although not considered in detail, these characteristics would increase the vulnerability to terrorist attack.

E.9 Historical Account of Spent Nuclear Fuel Shipments and Cumulative Impacts of Transportation

E.9.1 Spent Nuclear Fuel Shipment History

The SNF&INEL Final EIS (DOE, 1995) contains a survey of transportation incidents from 1949 to 1993. For 1949 through 1970, there were 14 incidents involving irradiated fuel elements. No packages approximating a Type B shipping cask were breached as a result of these incidents. Between 1971 and 1993, there were seven transportation accidents involving spent nuclear fuel. Three involved rail shipments, and four of these accidents involved truck shipments. None of these accidents resulted in damage to the structural integrity of a cask or release of contents.

The number of spent nuclear fuel shipments and amount of spent nuclear fuel shipped throughout the entire history of spent nuclear fuel shipment cannot be precisely determined from available information. The NRC keeps accurate records of more recent (since 1979) shipments of spent nuclear fuel.

Tables E-56 and E-57 describe the spent nuclear fuel shipments in the United States that have occurred since 1979. The data for the tables comes from NUREG-0725 (NRC, 1993). These tables show detailed spent nuclear fuel shipment information, including mode of shipment (highway or rail) and shipment trends over time. Data for shipment miles are taken primarily from a road atlas and have been rounded to the nearest hundred miles for each year. Data on quantity of spent fuel shipped were provided by shippers, and have been rounded to the nearest hundred kg (220 lb) (when more than 100 kg (220 lb) were shipped). These tables do not include DOE shipments (including Naval) of spent nuclear fuel, since these shipments are not regulated by the NRC.

Table E-56 Domestic and International Spent Nuclear Fuel Shipments: 1979-1992

Year	Domestic		International		Transient
	Highway	Railway	Export	Import	
1979	2	11	0	14	0
1980	73	5	2	55	0
1981	30	2	3	48	0
1982	80	0	1	43	0
1983	92	0	2	23	0
1984	209	3	2	34	0
1985	114	18	0	21	0
1986	88	15	0	17	0
1987	85	15	3	19	0
1988	10	7	0	15	0
1989	11	6	1	4	0
1990	0	8	2	0	3
1991	7	10	4	0	1
1992	17	6	0	0	0
Totals	**818**	**106**	**20**	**293**	**4**

Source: NRC, 1993

Table E-56 shows the pattern of highway and rail shipments throughout the period 1979 to 1992. The number of shipments generally rose in the early 1980s and then declined steadily through 1992. Import shipments have generally declined since 1980, with no shipments since 1989.

Table E-57 shows that most (91.4 percent) of approximately 1,200 spent nuclear fuel shipments during the 1979 to 1992 period were completed over highways. The highway shipments accounted for a larger percentage of the mileage (94.8 percent), meaning that the longer distance shipments tended to use the highways rather than rail. However, rail shipments moved 70 percent (by weight) of the fuel. This indicates that rail has been chosen for the larger shipments over shorter distances. A review of spent nuclear fuel shipments indicates that rail transportation was often used for shipments of commercial spent nuclear fuel, and research reactors almost exclusively used trucks (NRC, 1993).

E.9.2 Cumulative Impacts of Transportation

The SNF&INEL Final EIS (DOE, 1995) analyzed the cumulative impacts of transportation, taking into account impacts from: 1) historical shipments of spent nuclear fuel to Hanford Site, Savannah River Site, Idaho National Engineering Laboratory, Oak Ridge Reservation, and Nevada Test Site; 2) the programmatic alternatives; 3) other reasonably foreseeable actions that include transportation of radioactive material; and 4) general radioactive materials transportation that is not related to a particular action.

The total worker and general population collective doses are summarized in Table E-58. Total collective worker doses from all types of shipments (historical, the alternatives, reasonably foreseeable actions, and general transportation) were estimated to be 320,000 person-rem (130 LCFs) for the period of time 1943 through 2035 (93 yr). Total general population collective doses were also estimated to be 320,000 person-rem (160 LCFs). The majority of the collective dose for workers and the general population was due to the general transportation of radioactive material. Examples of these activities are

Table E-57 Summary Data for 1979-1992 Spent Nuclear Fuel Shipment Information

Year	*Number of Shipments*		*Kilograms Spent Fuel Shipped (thousands)*[a]		*Shipment Kilometers (thousands)*[b]	
	Highway	*Railway*	*Highway*	*Railway*	*Highway*	*Railway*
1979	16	11	0.1	30.2	12.9	3.7
1980	130	5	10.0	13.6	186.6	1.6
1981	81	2	7.9	6.0	62.0	0.6
1982	124	0	7.1	0.0	171.9	0.0
1983	117	0	36.6	0.0	134.6	0.0
1984	245	3	84.5	23.8	291.9	2.6
1985	135	18	74.0	119.4	114.1	14.0
1986	105	15	40.4	97.5	77.0	14.0
1987	107	15	82.3	101.4	67.3	13.5
1988	25	7	12.8	41.8	18.4	6.9
1989	16	6	0.1	30.8	26.9	2.7
1990	2	8	0.03	65.5	2.4	1.6
1991	11	10	0.1	98.4	15.5	2.4
1992	17	6	0.1	61.3	15.7	0.8
Totals	**1,131**	**106**	**356.0**	**689.7**	**1197.2**	**64.4**

Source: NRC, 1993

[a] *To convert kilogram values to pounds, multiply values given by 2.2.*

[b] *To convert kilometer values to miles, multiply by 0.62.*

Table E-58 Cumulative Transportation-Related Radiological Collective Doses and LCFs (1943 to 2035)

Category	*Collective Occupational Dose (person-rem)*	*Collective General Population Dose (person-rem)*
Historical	200	110
Spent Nuclear Fuel Shipments for SNF&INEL Final EIS Alternatives 1-5		
Truck	1.5 to 1,000	0.34 to 2,400
Rail	1.5 to 150	0.34 to 190
Reasonably Foreseeable Actions		
Truck	11,000	50,000
Rail	820	1,700
General Transportation (1943 to 2035)	310,000	270,000
Total Collective Dose	320,000	320,000
Total LCFs	130	160

Source: DOE, 1995

shipments of radiopharmaceuticals to nuclear medicine laboratories and shipments of commercial low-level radioactive waste to commercial disposal facilities. The total number of LCFs over the time period 1943 through 2035 was estimated to be 290. Over this same period of time (93 yr), approximately 28,000,000 people would die from cancer, based on 300,000 LCFs per yr (NRC, 1977a). It should be noted that the estimated number of transportation-related LCFs would be indistinguishable from other LCFs, and the transportation-related LCFs are 0.0010 percent of the total number of LCFs.

The transportation of foreign research reactor spent nuclear fuel, under any of the proposed options or alternatives in this EIS, is included in the calculated totals under the spent nuclear fuel shipments for SNF&INEL Final EIS Alternatives 1-5 (DOE, 1995). Proposed transportation of domestic and foreign spent nuclear fuel accounts for less than one percent of the total LCFs, attributable to the transportation of radioactive material, and foreign research reactor spent nuclear fuel accounts for less than one-quarter of that one percent.

E.10 Uncertainty and Conservatism in Estimated Impacts

The sequence of analyses performed to generate the estimates of radiological risk for the transportation of spent nuclear fuel includes: 1) determination of the inventory and characteristics, 2) estimation of shipment requirements, 3) determination of route characteristics, 4) calculation of radiation doses to exposed individuals (including estimation of environmental transport and uptake of radionuclides), and 5) estimation of health effects. Uncertainties are associated with each of these steps. Uncertainties exist in the way that the physical systems being analyzed are represented by the computational models, in the data required to exercise the models (due to measurement errors, sampling errors, natural variability, or unknowns simply caused by the future nature of the actions being analyzed), and in the calculations themselves (for example, approximate algorithms used by the computers).

In principle, one can estimate the uncertainty associated with each input or computational source and predict the resultant uncertainty in each set of calculations. Thus, one can propagate the uncertainties from one set of calculations to the next and estimate the uncertainty in the final, or absolute, result; however, conducting such a full-scale quantitative uncertainty analysis is often impractical and sometimes impossible, especially for actions to be initiated at an unspecified time in the future. Instead, the risk analysis is designed to ensure, through uniform and judicious selection of scenarios, models, and input parameters, that relative comparisons of risk among the various alternatives are meaningful. In the transportation risk assessment, this design is accomplished by uniformly applying common input parameters and assumptions to each alternative. Therefore, although considerable uncertainty is inherent in the absolute magnitude of the transportation risk for each alternative, much less uncertainty is associated with the relative differences among the alternatives in a given measure of risk.

In the following sections, areas of uncertainty are discussed for the assessment steps enumerated above. Special emphasis is placed on identifying whether the uncertainties affect relative or absolute measures of risk. The degree of reality conservatism of the assumption is addressed. Where practical, the parameters that most significantly affect the risk assessment results are identified.

E.10.1 Uncertainties in Spent Nuclear Fuel Inventory and Characterization

The spent nuclear fuel inventories (i.e., number of shipments) and the physical and radiological characteristics are important input parameters to the transportation risk assessment. The potential amount of transportation for any alternative is determined primarily by the projected spent nuclear fuel inventory and assumptions concerning shipment capacities. The physical and radiological characteristics are important in determining the amount of material released during accidents and the subsequent doses to exposed individuals through multiple environmental exposure pathways.

The development of projected spent nuclear fuel inventory and characterization data used to support the EIS is described in Appendix B. Uncertainties in the spent nuclear fuel inventory and characterization will be reflected to some degree in the transportation risk results. If the spent nuclear fuel inventory (number of elements) is overestimated (or underestimated), the resulting transportation risk estimates also will be overestimated (or underestimated) by roughly the same factor. However, the same spent nuclear fuel inventory estimates are used to analyze the transportation impacts of each of the EIS alternatives. Therefore, for comparative purposes, the observed differences in transportation risks among alternatives are believed to represent unbiased, reasonably accurate estimates from current information in terms of relative risk comparisons.

The spent nuclear fuel type selected for the accident risk calculations was chosen to maximize the potential accident risk results. All accidents were analyzed for fuel that is less than 1 year old. However, much of the fuel has already been out of the foreign research reactors for more than 1 year and may not be brought back for several years. For calculations of MEIs, the cask loaded with the maximum possible amount of radioactive material should have been and was considered. However, the risk values were calculated under the assumption that all casks were loaded to this maximum value. Depending on the implementation of the program, very few, if any, of the casks would be carrying fuel as new as that used in the accident analysis. Selection of another spent nuclear fuel type, or consideration of all spent nuclear fuel types in detail, would result in accident risks less than those reported in the assessment of alternatives in this appendix.

E.10.2 Uncertainties in Casks, Shipment Capacities and Number of Shipments

The amount of transportation required for each alternative is based in part on assumptions concerning the packaging characteristics and shipment capacities for truck and rail modes. Representative shipment capacities have been defined for assessment purposes based on probable future shipment capacities. In reality, the actual shipment capacities may differ from the predicted capacities, so that the projected number of shipments, and consequently the total transportation risk, would change. However, although the predicted transportation risks would increase or decrease accordingly, the relative differences in risks among alternatives would remain about the same. It is in fact likely that DOE would deploy a large capacity truck or rail cask for large intersite shipping campaigns.

For the purposes of analysis, Phase 1 was assumed to last exactly 10 years and Phase 2 was assumed to last exactly 3 years. Realistically, the Phase 2 site may be ready somewhat sooner or later. Additionally, the fractions of the fuel arriving during each phase may not be precisely proportional to the duration of the phase. However, the risk changes are small when compared with the conservatism introduced in the radiological calculations.

The number of shipments to and from various points comes from a complex series of models of how the policy may be implemented. They are not intended to define how the policy would be implemented. Instead, they describe somewhat generally how the policy would be implemented. The risk factors for all conceivable routes between DOE sites and ports of entry are given to show that a slight deviation from the shipment pattern modeled could have a negligible affect on risk. For example, if the policy were being implemented with fuel arriving in the eastern United States going to Savannah River Site and fuel arriving in the western United States going to Idaho National Engineering Laboratory, the risk impact of transporting a few casks from eastern ports to Idaho National Engineering Laboratory (presumably for onsite logistical reasons) would have a small impact on program risk.

E.10.3 Uncertainties in Route Determination

Representative routes have been determined between all origin and destination sites considered in the EIS. The routes have been determined consistent with current guidelines, regulations, and practices, but may not be the actual routes that would be used in the future. In reality, the actual routes could differ from the representative ones in terms of distances and total population along the routes. Moreover, in that the assessment considers spent nuclear fuel could be transported over an extended period of time starting at some time in the future, the highway and rail infrastructures and the demographics along routes could change. These effects have not been accounted for in the transportation assessment, however, it is not anticipated that these changes would significantly affect relative comparisons of risk among the alternatives considered in the EIS.

E.10.4 Uncertainties in the Calculation of Radiation Doses

The models used to calculate radiation doses from transportation activities introduce a further uncertainty in the risk assessment process. It is generally difficult to estimate the accuracy or absolute uncertainty of the risk assessment results. The accuracy of the calculated results is closely related to the limitations of the computational models and to the uncertainties in each of the input parameters that the model requires. The single greatest limitation facing users of RADTRAN, or any computer code of this type, is the scarcity of data for certain input parameters.

Uncertainties associated with the computational models are minimized by using state-of-the-art computer codes that have undergone extensive review. Because there are numerous uncertainties that are recognized but difficult to quantify, assumptions are made at each step of the risk assessment process that are intended to produce conservative results (i.e., overestimate the calculated dose and radiological risk). Because parameters and assumptions are applied equally to all alternatives, this model bias is not expected to affect the meaningfulness of relative comparisons of risk; however, the results may not represent risks in an absolute sense.

In order to understand the most important uncertainties and conservatism in the transportation risk assessment, the results for all cases were examined to identify the largest contributors to the collective population risk. The results of this examination are discussed briefly below.

For truck shipments, the largest contributors to the collective population dose were found to be, in decreasing order of importance: 1) incident-free dose to members of the public at stops, 2) incident-free dose to transportation crew members, 3) incident-free dose to members of the public sharing the route (on-link dose), 4) incident-free dose to members of the public residing along the route (off-link dose), and 5) accident dose risk to members of the public. Approximately 80 percent of the estimated public dose was incurred at stops, 15 percent by the on-link population, and 5 percent by the off-link population. In general, the accident contribution to the total risk was negligible compared with the incident-free risk.

For rail shipments, the largest contributors to the collective population dose were found to be, in decreasing order of importance: 1) incident-free dose to transportation crew members, 2) incident-free dose to members of the public residing along the route (off-link dose), 3) incident-free dose to members of the public at stops, 4) incident-free dose to members of the public sharing the route (on-link dose), and 5) accident dose risk to members of the public. Approximately 70 percent of the estimated public dose was incurred by the off-link population, 25 percent by the population at stops, and 5 percent by the on-link population. As with truck shipments, the accident contribution to the total risk in general was negligible compared with the incident-free risk, even when the spent nuclear fuel type was selected to maximize the accident risk results.

As shown above, incident-free transportation risks are the dominant component of the total transportation risk for both truck and rail modes. The most important parameter in calculating incident-free doses is the shipment external dose rate (incident-free doses are directly proportional to the shipment external dose rate). For this assessment, it was assumed that all shipments would have an external dose rate at the regulatory limit of 10 mrem per hr at 2 m. In practice, the external dose rates would vary from shipment to shipment. Although it is conceivably possible to load a cask with enough fresh foreign research reactor spent nuclear fuel to obtain a dose rate equal to the regulatory limit, experience has shown this to be unlikely. In fact, the observed average dose rate described in Appendix B is approximately ten times lower than the regulatory limit. During the shipments of foreign research reactor to MOTSU and ultimately to Savannah River Site, the State of North Carolina detected less than 1 mrem on contact with the cask and no radiation above background at 2 m (Massey, 1994). Therefore, the incident-free risks are conservative, and would be ten times lower if calculated with the observed average dose.

Finally, the single largest contributor to the collective population doses calculated with RADTRAN was found to be the dose to members of the public at truck stops. Currently, RADTRAN uses a simple point-source approximation for truck-stop exposures and assumes that the total stop time for a shipment is proportional to the shipment distance. The parameters used in the stop model were based on a survey of a very limited number of radioactive material shipments that examined a variety of shipment types in different areas of the country (Wilmot, 1981). It was assumed that stops occur as a function of distance, with a stop rate of 0.011 h per km (0.018 h per mile). It was further assumed that at each stop, an average of 50 people are exposed at a distance of 20 m (66 ft). In RADTRAN, the population dose is directly proportional to the external shipment dose rate and the number of people exposed, and inversely proportional to the square of the distance. The stop rate assumed results in an hour of stop time per 100 km (62 miles) of travel.

Based upon the qualitative discussion with shippers of spent nuclear fuel, the parameter values used in the assessment appear to be conservative. However, data do not exist to qualitatively assess the degree of conservatism in the stop-dose model. As a practical matter, it is conceivable that DOE could take steps to control the location, frequency, and duration of truck stops if necessary. However, based on the regulatory requirements for continuous escort of the material (10 CFR 73) and the requirement for two drivers, it is clear that the trucks would be on the move essentially one-hundred percent of the time until arrival at the destination. Therefore, the calculated impacts are extremely conservative. By using these conservative parameters, the calculations in this EIS are consistent with the RADTRAN default values and the SNF&INEL Final EIS (DOE, 1995).

Shielding of exposed populations is not considered. For all incident-free exposure scenarios, no credit has been taken for shielding of exposed individuals. In reality, shielding would be afforded by trucks and cars sharing the transport routes, natural topography, and the houses and buildings in which people reside. Incident-free exposures to external radiation could be reduced significantly depending on the type of shielding present. For residential houses, shielding factors (i.e., the ratio of shielded to unshielded exposure rates) have been estimated to range from 0.02 to 0.7, with a recommended value of 0.33. If shielding were to be considered for the maximally exposed resident living near a transport route, the calculated doses and risks would be reduced by approximately 70 percent. Similar levels of shielding may be provided to individuals exposed in vehicles. However, consideration of shielding does not significantly affect the overall incident-free risks to the general population.

Post-accident mitigative actions are not considered for dispersal accidents. For severe accidents involving the release and dispersal of radioactive materials in the environment, no post-accident mitigative actions, such as interdiction of crops or evacuation of the accident vicinity, have been considered in this risk assessment. In reality, mitigative actions would take place following an accident in accordance with U.S. Environmental Protection Agency radiation protection guides for nuclear incidents (EPA, 1991). The effects of mitigative actions on population accident doses are highly dependent upon the spent nuclear fuel type involved and the severity, location, and timing of the accident. For this risk assessment, ingestion doses are only calculated for accidents occurring in rural areas (the calculated ingestion dose, however, assumes all food grown on contaminated ground is consumed and is not limited to the rural population).

Examination of the severe accident consequence assessment results has shown that ingestion of contaminated foodstuffs contributes on the order of 50 percent of the total population dose for rural accidents. Interdiction of foodstuffs would act to reduce, but not eliminate, this contribution.

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